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MISA ISSUES RESOLUTION PROCESS

ISSUE RESOLUTION COMMITTEE REPORTS

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Jim Bradley, Minister/ministre

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MISA ISSUE RESOLUTION PROCESS

ISSUE RESOLUTION COMMITTEE REPORT

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PREFACE

With the Monitoring Regulations promulgated for all nine industrial sectors, the Ministry is now moving into the critical stage of the MISA program: development of the Effluent Limits Regulations.

The Joint Technical Committees will be reconvened to deliberate and recommend the Effluent Limits Regulations for each sector using the general regulation development process outlined in the MISA White Paper of 1986.

Each step in the regulation development process will, however, require the application of scientifically sound and defensible procedures and criteria. Thus, a set of standardized procedures and criteria must be established for each Joint Technical Committee to follow. In this way, all regulations will be consistent and equitable among all sectors.

The "Issues Resolution Process"* was intiated by the Ministry as a means of establishing the standard procedures and criteria to be used in developing limits regulations.

Over the past several months, special working groups called Issue Resolution Committees (IRCs) were formed with representation from the Ministry, Industry, and Municipalities; representatives from Environment Canada and the MISA Advisory Committee also participated. These committees have examined the regulation development process and have recommended procedures and criteria for each of the regulation development steps. This document contains all the final reports of the Issue Resolution Committees.

*NOTE: *For a complete description of the Issues Resolution Process, including a review of the regulation development steps, reference should be made to the document titled MISA Issues Resolution Process – Draft Summary Report.*

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FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

QUALITY ASSURANCE AND QUALITY CONTROL

ISSUE

To provide a strategy for evaluating the quality and utility of MISA monitoring data, and to document the function and use of information arising from MISA field and laboratory quality assurance, quality control (QA/QC), and interlaboratory comparison activities.

BACKGROUND

The frequency of occurrence and the levels of analytes reported by MISA industries will impact on the selection of parameters, determination of BAT(EA) and the setting of effluent limits. The quality of these data must be evaluated to ensure defensible decisions.

The primary data quality concerns include the possibility that:

- low results represent false positive findings,
- non-detected results represent false negative findings,
- results are underestimated or overestimated,
- analytes are misidentified.

When measurable levels are observed with sufficient frequency, one may also wish to identify the major source of uncertainty (process changes, sampling and sample variability, or analytical measurement), the comparability of data taken from different sources, and the potential for inaccuracy.

To document the quality of their data, the regulated industries are required to submit QA/QC data. Field data includes travelling blanks, travelling spiked blanks, and duplicate samples for specified analytes, at specified locations, and at a specified frequency. In addition, the laboratories performing analyses for the industry must retain the results of certain laboratory QC checks (blanks, spiked blanks, spiked samples, and replicate analyses as specified in the MISA regulation) for possible audit/review by the Ministry.

To assess the comparability of data from different sources, a limited number of interlaboratory comparison studies have been implemented for certain analytes.

A standardized strategy, "Guidance Document for the Assessment and Interpretation of Analytical and Quality Control Data", has been developed[1]. Its use would ensure that a consistent approach is taken in determining which data is sufficiently reliable for the ultimate purpose of limit setting. This strategy is based on best scientific judgement and generally accepted data handling procedures.

DISCUSSION

Data Quality Objectives

A critical first step in ensuring a useful data set is to establish an agreement between the client (program manager, data user) and the data generator (industry, laboratory) as to the overall quality of data required - a data quality objective (DQO). In the case of the MISA monitoring regulations, this was achieved through the Joint Technical Committees and their Analytical Working Groups on the basis that the program was intended to produce data which would be used to establish effluent limits.

For MISA, the DQO agreements resulted, in part, in the inclusion of specific quality control and quality assurance requirements within the General Regulation. These included the use of well documented methods (conforming to guiding principles and protocols), specification of a maximum value for a laboratory's method detection limit, a requirement for routine analysis of laboratory QC samples, and the introduction and analysis of periodic field QC samples. These regulated requirements ensured the provision of the basic QC data necessary to evaluate and assess the overall MISA data set. Laboratory QC data would be used primarily to forestall the reporting of biased or suspect analytical results. Field QC data would assist data users in interpreting the impact of field activities on the validity of the data reported. In general a minimum amount of QA/QC data was required, sufficient to assess bulk data quality rather than individual data quality.

U.S. EPA Approach

The U.S. EPA has taken a variety of approaches to address this concern for data quality. The approach adopted varies from regulation to regulation. It may include:

- development of program DQO's prior to regulation,
- specification of analytical methods,
- requirement for use of certified laboratories,
- infrequent use of performance evaluation standards,
- requirement for specified field/lab QA/QC practices,

U.S. EPA regulations generally address the issue of compliance with predetermined limits. If an industry reports a number which exceeds the limit, the number is accepted as reported. The EPA National Pollution Discharge Elimination System (NPDES) is a permit based system. National guidelines for permit writing exist and each discharger must have a permit which defines how they are to sample and submit data.

The primary EPA concern is that industry does not adjust data to avoid prosecution. Laboratory certification only partially addresses this issue. Certification programs include inspection and evaluation of performance by infrequent check samples. The inspection may include a requirement to produce specific laboratory QC information and evidence of a quality management program. The amount and type of QA/QC data required varies greatly depending on the regulatory program.

Ministry Approach to Monitoring Regulations

The Ministry has adopted elements of all of the EPA approaches, both within and outside of the regulation. These include a number of guideline documents on analytical and good laboratory practices, plus site and laboratory inspections. But there are differences in perspective.

The MISA Monitoring Regulation is concerned with data collection across a sector. The Ministry expects, and verifies by site inspection, that industry has followed sampling and analytical principles stated in the regulation. The Ministry then uses each industry's data set in order to determine the performance characteristics of potential BAT(EA) treatment systems. This includes a review of the internal consistency of data and an evaluation of its overall quality. Ultimately the nature of the data reported, including level, frequency of occurrence, and quality, will impact on the selection of parameters as well as the limit setting process. The primary concern is not with the quality of individual values, but rather with the general validity of the total data set.

Data Comparability

The comparability of data across an industrial sector will depend on the comparability of standards used by laboratories, and on the methodologies used. Laboratories are required to verify the accuracy of their standards relative to reference standards when available. In addition interlaboratory comparison (ILC) studies have been initiated by both MOE and the industrial sectors to determine the impact, if any, of differences in standards and methods for typical and critical analytes. This information will ideally affirm that differences observed among various industrial effluent streams are in fact due primarily to differences in the effluent quality.

In general, interlaboratory comparison studies cannot be used to determine a correction factor for a specific laboratory's data. If the findings of an ILC suggest a laboratory bias exists, this must be verified by comparing that laboratory's reported effluent data against data reported by other laboratories for similar effluents. Only then can an appropriate action be determined.

RECOMMENDATIONS

The following are the recommendations proposed by the Issue resolution Committee on the use of QA/QC data:

- A standardized procedure and set of criteria should be applied to assess data quality. One such procedure and set of criteria are contained in a report, titled "Guidance Document for the Assessment and Interpretation of Analytical and Quality Control Data". The procedure and criteria contained in the report enables examination of data consistency, trends, discontinuities, sources of data variability, and overall data comparability. It also allows identification of the potential for under- or over-

estimation of resultant values, and for false positive or false negative decisions for specific analytes.

- Effluent monitoring data should be evaluated by graphical and statistical techniques to identify patterns and anomalies. Effluent data should also be reviewed across a sector to establish overall data variability and consistency.

- The data evaluation process should include interaction of Ministry sector specialists, data managers, laboratory scientists, and quality assurance staff.

- Inter-laboratory comparison data should be examined to evaluate comparability among laboratories. Such data are not to be used to correct reported effluent data.

- Effluent data which is deemed satisfactory, based on the QA/QC evaluation, may be used to establish effluent limits.

- Effluent monitoring data which is deemed to be less satisfactory may still be useful for other program purposes and should be retained.

UNRESOLVED CONCERNS

None.

REFERENCES

Ontario Ministry of the Environment (1990). Guidance Document for the Assessment and Interpretation of Analytical and Quality control Data. Laboratory Services Branch, Rexdale, Ontario, February (Draft).

APPENDIX

Guidance Document for the Assessment and Interpretation Of Analytical and Quality Control Data

DRAFT

February, 1990

Introduction

This document provides an approach to the interpretation of analytical results and associated QC data. The purpose of this document is threefold:

1) to identify the function and use of various types of quality control data;

2) to outline an applications strategy for assessing quality control data;

3) to provide a summary of interpretations that can be drawn from an analytical results dataset.

These proposals are based on best scientific judgement and generally accepted data handling procedures. It is recognized that other approaches may be developed which are equally appropriate to use. There are no universally adopted scientific rules governing data quality interpretation and usage.

Components of an Analytical Dataset

An analytical dataset is more than a collection of numbers. In its simplest form it incorporates several essential and interdependant characteristics. In total these elements provide insight into the overall quality and validity of conclusions that may be drawn.

Each individual test result has associated with it a permanent link to the method and laboratory responsible for the result. As well, the individual test result may be qualified by the analyst with a remark code(s) to attest to their degree of confidence in its quality or absolute value.

Additional database elements may be less consistently named or reported but remain essential to the integrity of the whole dataset. These include the quality control elements of blanks, spikes and duplicates. These QC elements can be associated with field and sampling activities for assessing analyte contamination and perishability (e.g. travelling blank, travelling spiked blank, etc.). Or they can be associated with laboratory operations for assessing concerns such as recovery, bias, precision and contamination (lab blank, spike, replicate, spiked sample, etc.).

All of these components (the individual sample test result; its method code; any associated remark code(s); the field and laboratory QC test results) are intimately related and are essential to the interpretation of the dataset as a whole.

Data Quality Objectives

The first step in ensuring a useful dataset is to establish between the program manager/data user (the client) and the data generator (the industry and/or the laboratory) an agreement as to the overall quality of data required -- the data quality objectives (DQO).

In the case of the MISA monitoring regulations this was done through the Joint Technical Committees (JTCs) and their Analytical Working Groups (AWGs) on the basis that the program was designed to establish effluent limits. The DQO agreements resulted, in part, in the inclusion of specific quality control and assurance requirements within the General Regulation. These included the use of well documented methods (conforming to guiding principles and protocols), the routine analysis of laboratory QC samples and the introduction of periodic field QC samples. These requirements supported the original DQOs and ensured the provision of the basic QC data necessary to evaluate and assess the analytical dataset.

Dataset Review and Interpretation

It must be understood that each result or set of results within the dataset will be assessed with one of the following conclusions drawn:

a) the data is of high, reliable quality and should be used to achieve the goals of the program;

b) the data is of known limited quality and could be used carefully, noting any identifiable biases, minor problems and impacts;

c) the data is of doubtful quality and should be used only as general information; this data is not to be treated mathematically or used as the basis for any decisions;

d) the data is not useful, highly suspect and unreliable, it should be discarded from the dataset to avoid further use (data records and reasons for discarding should be maintained).

The following items should be included in the data review:

1) all industry data must first be reviewed on an industry by industry and pipe by pipe basis to identify site specific concerns or peculiarities.

2) field QC data must be reviewed to assess analyte ruggedness and contamination problems.

3) the test results, when reviewed on a laboratory specific basis, may identify limitations or problems related to corresponding dataset elements of method/remarks codes.

4) laboratory QC data must be consulted to identify any performance (recovery, precision, bias) concerns.

5) corrections to test results must be performed only where there exists sufficient evidence to warrant it.

APPENDIX I

MISA DATA REPORTING PROTOCOL

Current Status

The MISA sectoral regulations require direct dischargers to report the results of all analyses which fall at or above the laboratory calculated method detection limit (LMDL). The general regulation informs direct dischargers that they may report analytical results which fall below the LMDL as either the actual result with the remark code "<DL" or the LMDL as "<LMDL" with the remark code "<DL".

Example:

The regulation MDL (RMDL) is 10. The LMDL is 5.
The analytical result is 6. The direct discharger reports 6.
The analytical result is 4. The direct discharger reports either:

a) "4" remark "<DL", or
b) "<5" remark "<DL"

PROPOSED DATA REPORTING PROTOCOL

a) For results greater than or equal to the calculated RMDL the observed value is reported accompanied by the laboratory specific method code, the unit of measure code, and any appropriate remark code.

b) For results less than the RMDL but not less than LMDL, the observed value is reported accompanied by the laboratory-specific method code, the unit of measure code, and the remark code"<T".

c) For results less than LMDL but not less than RMDL/10 the observed result is reported accompanied by the laboratory-specific method code, the unit of measure code, and the remark code "<DL".

d) For results less than RMDL/10 or for which there was no observable result, the result is reported as the RMDL divided by ten, prefixed by "<" and accompanied by the laboratory-specific method code, the unit of measure code, and the remark code "<W".

e) Results of analysis prefixed by a "<" sign, which are numerically greater than the RMDL are to be qualified with an interference remark code and accompanying explanatory text.

Purpose

The purpose of this protocol is to accomplish the following:

i) to enable the reporting of all observed data, at the discretion of the laboratory;

ii) to allow for and provide a consistent approach to reporting low level data (at or near the laboratory MDL);

iii) to establish a single numeric value and reporting format for no results or "zero" results;

iv) to provide a method for reporting problems with interferences and/or matrix effects that preclude reaching the regulatory or laboratory MDL.

Rationale

As stated earlier, there are many ways to report and qualify analytical data. There is only one need however and that need is to have data reported in a consistent fashion to facilitate interpretation and prevent inappropriate use.

The nature of the (MISA monitoring) program is such that there will be a number of laboratories providing data and each laboratory will be operating within its own capabilities of (amongst others) precision and sensitivity. The precision and sensitivity characteristics are defined by the regulations Method Detection Limits (RMDL) which when put to practice in any given laboratory result in a laboratory specific MDL (LMDL) which may be much less than RMDL.

For the purposes of the regulation, all observed data above RMDL must be reported but this eliminates an opportunity to assess data below RMDL, data which could be very useful to the program.

The protocol was developed to allow for the reporting of all data regardless of the source while providing a means to identify not only the sensitivity limits of the individual laboratories but also a consistent fashion of reporting "zero" or "no observed response". The assigned value for "zero" as 1/10 of the RMDL value is totally arbitrary but accommodates all laboratories capabilities and makes identification of reported "zeros" much easier.

The impact of interferences and matrix effects on reported values is also covered by use of a standardized reporting format and remark code. Not every analyte will be observable in every sample at or above the RMDL. There will be cases when no reportable or observable result is available at 2, 5, 10, even 100 times the RMDL. The uniform identification of these values and their limitations is essential to protect against inappropriate data use.

Finally, two new concepts "W" and "T" are introduced to initiate an appreciation of data quality. All reported values from LMDL to RMDL are uniquely qualified by the remark code "T" signifying to the data user that this value as an independent result or observation is variable or uncertain. "T" means that the data user must confirm presence and quantity with additional observations which will support or give grounds to reject the value(s). The remark code "W" is used as a flag for "zero", no observed response.

Together these flags will help establish the "real data" within a dataset and quickly identify the zero points and those uncertain (quality/quantity) values.

Review of Quality Control Sample Types

Laboratory Method Blanks

- may be zero for many tests, but need not be;
- normally used to correct for labware/reagent contamination;
- may be erratic due to lab environment;
- corrections should be controlled (evaluated prior to use);
- failure to correct properly for the blank may lead to:
- false positive decisions (lack of correction);
- false negative decisions (over-correction);

Assessment Tools:

Analyte and matrix specific calculations of:

- percent occurrence of positives;
- median or mean values, range, and standard deviation;
- stability over time (control chart).

Laboratory Spiked Method Blanks or Spiked Samples or Travelling Spiked Samples

- provides a check on calibration accuracy and method recovery;
- expected to be 100% on average within a range of $\pm$ 20%;
- may show consistent under-recovery e.g. 45% $\pm$ 20%;

- may show erratic under or over-recovery e.g. 75% ± 55%;
- generally not used to correct for recovery on samples;
- comparison between spiked method blanks and spiked samples may reveal matrix effects;
- comparison of recoveries across a scan may reveal systematic factors affecting several or all analytes;
- comparison among laboratories may reveal systematic factors.

Assessment Tools:

Analyte and matrix specific calculations of:

- percent occurrence of positives;
- median or mean values, range, and standard deviation;
- stability over time (control chart).

Laboratory Replicates

- provide a measure of within and between run precision;
- can identify biases and control problems;
- average range (difference between paired results) provides an estimate of laboratory precision;
- outliers suggest lab contamination or sample non-homogeneity.

Assessment Tools:

Analyte and matrix specific calculations of:

- percent occurrence of positives;
- observed differences, and distribution;
- median or mean difference, range of differences;
- stability over time (control chart);
- standard deviation of data pairs.

Travelling Blanks

- expected to be less than the laboratory MDL unless field operations are introducing sample contamination;
- may show consistent or erratic under-recovery;
- comparison against the laboratory spiked method blank data may help to determine whether the sample has deteriorated or whether it is a laboratory recovery or control problem.

Assessment Tools:

Analyte and matrix specific calculations of:

- percent occurrence of positives;
- median or mean values, range, and standard deviation;
- stability over time (control chart);

Duplicate Field Samples

- average range can be compared against the average difference for laboratory replicates;
- a ratio greater than 1.5 suggests that field variability is dominating laboratory variability;
- can be used to assess the reality of day to day effluent data variability.

Assessment Tools:

Analyte and matrix specific calculations of:

- percent occurrence of positives;
- median or mean differences, range of differences;
- distribution of differences;
- stability over time (control chart);
- standard deviation of data pairs.

Data Quality Review and Evaluation Procedure

Step 1: MISA Sample Database

- sort MISA database by analyte, company, site;
- calculate % occurence for each analyte.
- calculate median, arithmetic mean, geometric mean, minimum and maximum values for each analyte;
- classify analyte database as:

    a) never found;

    b) infrequently found;

    c) frequently found;

- boundary between cases b) and c) probably quite wide.

Step 2: MISA Duplicate Samples Database

- sort by analyte, company, site;
- calculate median, arithmetic mean, geometric mean, minimum and maximum values for each analyte.

Step 3: MISA Travelling Spiked Blank Data

- sort by analyte, company, site;
- calculate median, arithmetic mean, geometric mean, minimum and maximum values for each analyte.

Step 4: MISA Travelling Blank Data

- sort by analyte, company, site;
- calculate median, arithmetic mean, geometric mean, minimum and maximum values for each analyte.

Step 5: Evaluate "Never Found" Analytes (Flowchart 1)

- determine the possibility for false negative conclusions:
    - over-correction for laboratory blanks;
    - gross under-recovery of travelling spiked blanks;
- if risk of false negatives is low these analytes are candidates for delisting or reduced frequency sampling.

Step 6: Evaluate "Infrequently Found" Analytes (Flowchart 2)

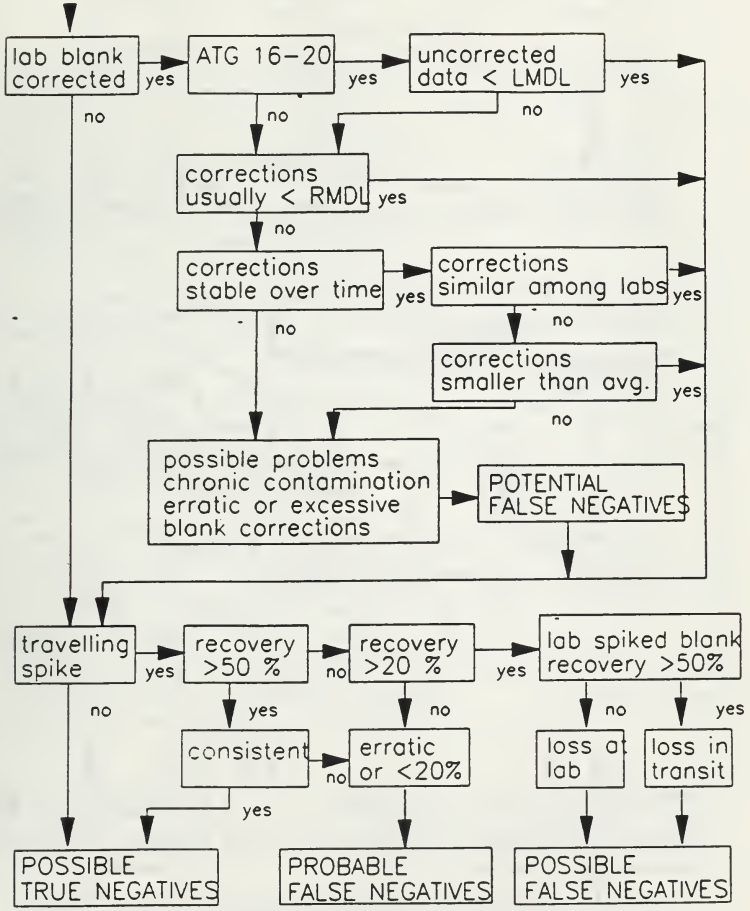
- determine the possibility for false negative conclusions:
    - over-correction for laboratory blanks;
    - gross under-recovery of travelling spiked blanks;
- determine the possibility for false positive conclusions:
    - under-correction for laboratory blanks;
    - chronic positive travelling blanks;
    - chronic lab contamination (blanks/replicates)
- if risk of false positives is low these analytes are candidates for contunued but reduced frequency sampling.

Step 7: Evaluate "Frequently Found" Analytes (Flowcharts 3A, 3B)

- assess likelihood of over or under-estimation based on recovery of travelling spiked blanks, laboratory spiked blanks, and laboratory spiked samples;
- assess possibility of error in blank corrections;
- assess precision from field duplicates;
- if necesssary assess precision from laboratory replicates;
- these are generally candidates for statistical and graphical evaluation of effluent variations/trends.

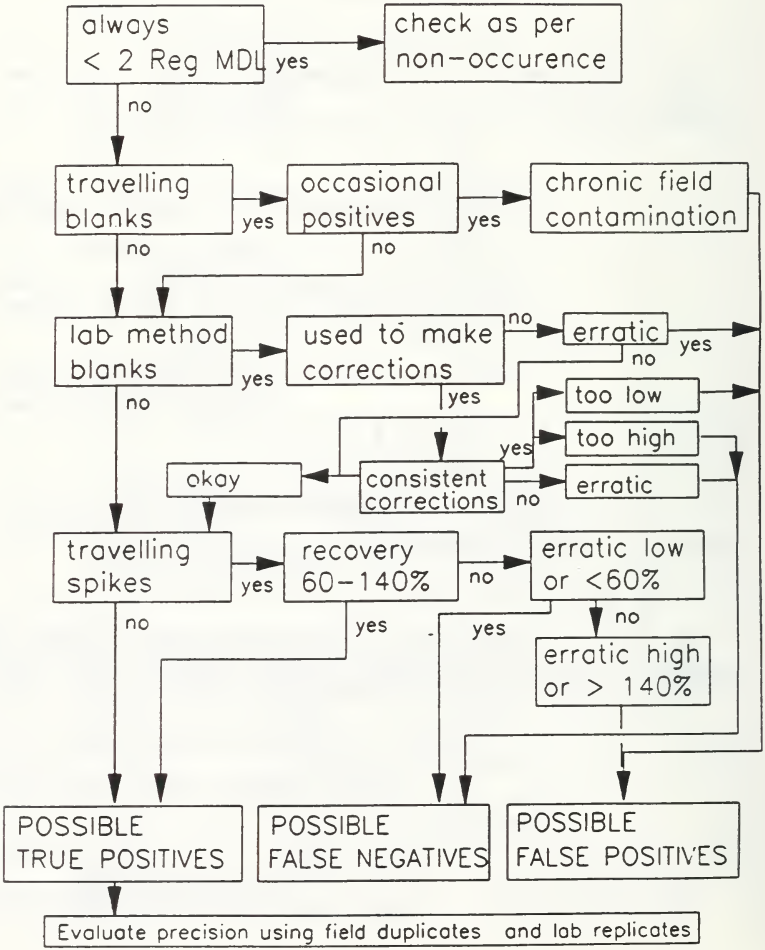
FLOWCHART 1

NON-OCCURENCE OF ANALYTE
Data less than laboratory MDL



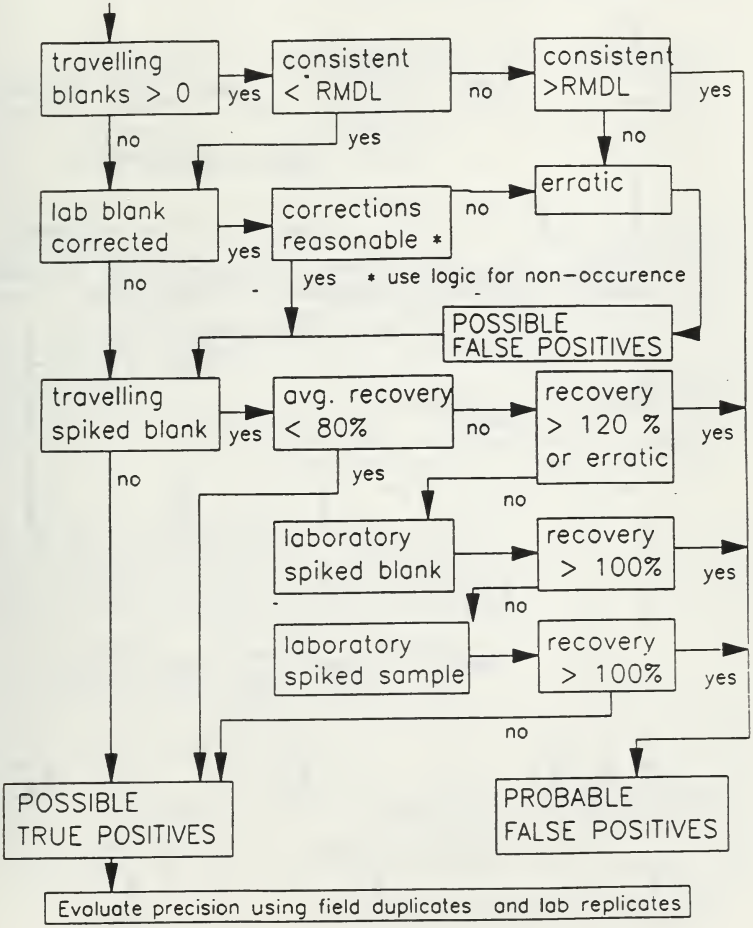
FLOWCHART 2

INFREQUENT OCCURRENCE



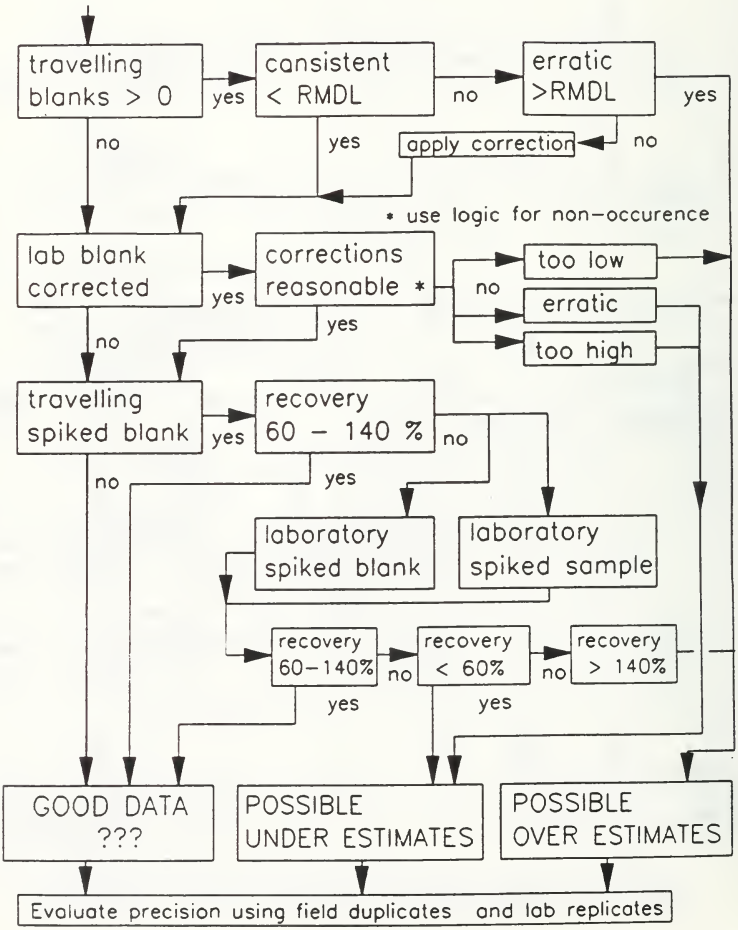
FLOWCHART 3A

FREQUENT OCCURENCE (LOW LEVEL)
Data usually < 2 x Reg MDL



FLOWCHART 3B

FREQUENT OCCURENCE (HIGH LEVEL)
Data usually > 2 x Reg MDL



FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

MONITORING DATA ANALYSIS

ISSUE:

To determine what statistical tools would be needed and how they would be applied to the MISA effluent monitoring data for the purpose of:

- *general data analysis*
- *variability analysis and calculation of effluent performance values*
- *reporting the monitoring data to the public.*

To determine and recommend the criteria for the use of non-MISA data.

BACKGROUND

The first phase of the MISA Program is in progress. The data generated from the monitoring program are extensive. To interpret the data bases and to use them in a meaningful way for limits derivation and reporting to the public requires statistical analysis[1]. The tools to be used in the statistical analysis and their functions are discussed in this position paper.

Generally, where applicable the experience of the United States Environmental Protection Agency (EPA) has been used as the basis for the statistical approaches and methods adopted. Where departure(s) from the EPA procedures have occurred, they are noted in the specific discussion sections.

THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) EXPERIENCE

The EPA, under the Clean Water Act (CWA) dealt with a significant number of industrial sectors, the latest being the Organic Chemicals, Plastics and Synthetic Fibres (OCPSF) industries. Under Section 308 of the CWA, EPA has the authority and the ability to collect technical, financial and economic information to assist in its regulatory tasks. The EPA used surveys, publicly available data, real plant data and sampling to develop their data base for the development of national guidelines.

In the OCPSF sector, the database included 304 plants and 126 primary pollutants. For the OCPSF sector, EPA promulgated national limitation guidelines for 63 toxic contaminants based on effluent concentrations only. These guidelines were then used in the National Pollutant Discharge Elimination System (NPDES) for developing site specific permits based on mass loading limitations.

The OCPSF sector limits were based on the 99th percentile (daily) and the 95th percentile (monthly) of the distribution of the data, on a never to exceed basis. A single exceedance above the effluent limit was considered a violation. However, EPA used a "significant non-compliance criterion" in its reporting requirements to the agency and set standards for this criterion.

General Data Analysis

In the OCPSF sector, the EPA analyzed plant data individually. Non-detected values were censored at specified minimum levels of detection, the distribution tested for lognormality and averages calculated. For daily data the autocorrelation, the correlation between consecutive day effluent values was calculated for plants that had the necessary data. EPA, using best professional judgement, sub-categorized the OCPSF sector into two homogeneous subgroups to ensure uniform best available technology (BAT) limits for similar subgroups.

Variability Analysis and Calculation of Performance Values

The EPA, in setting performance standards, identified BAT plants. An average variability among the BAT plants was built around an average of long term data of BAT plants to set the performance standards. The average, weighted in proportion to the number of non-detects found, produced the long term average (LTA) for each pollutant in each plant. The median of these LTA's was then used as the target LTA for limits.

The variability or uncertainty in the effluent pollutant concentrations around the LTA[2] was taken into account by calculating the ratio of either the 95th or 99th percentile to the mean. EPA called this ratio a variability factor (VF). Variability factors were calculated as daily maximum VF(1), 30-day means VF(30) for conventional pollutants, and monthly means based on four samples per month VF(4), for trace organic pollutants. The performance value was set as the product of the median LTA and the average variability factor.

Reporting Monitoring Data to the Public

EPA did not report the data to the public through regular reports, but any discharge data were available to the public on request.

DISCUSSION

Overview

For treatment of outliers, characterization of distribution, accounting for autocorrelation, calculation of averages, subcategorization and variability analysis, all data should be analyzed on a plant-by-plant basis. A correct estimate of the variability of the pollutant is important. The choice for data analysis would be to pool data for a given pollutant over all the plants or to perform plant-by-plant analyses.

The random variability when data for a pollutant in all plants are pooled includes the variability between the plants. Analysis of data plant-by-plant would eliminate the variability between plants and should give a proper estimate of the random variability of

the pollutants within each plant. The random variability within each plant can then be averaged to obtain a good representation of the pollutant's random variability. Performance values are set, accounting for variability within a plant and hence averaging of plant-by-plant data is better than averaging pool data.

Another advantage of plant-by-plant approach is that if for some reason entire data from a plant have to be deleted, the analysis is not further complicated. The EPA analyzed the data on a plant-by-plant basis.

It is intended that the data collected under the MISA program be analyzed statistically for the purpose of general data analysis, setting of performance values and reporting to the public in the order given in Figure 1.

General Data Analysis

Data Editing: Treatment of Non-Detected Values

In the MISA Program as many as 179 chemicals will be analyzed and many of them may be reported as below the detection limit (< DL). In the treatment of < DL values frequency of occurrence/consistency should be taken into account. As the detection limit value is used to censor the low level results, < DL values can lie anywhere between 0 and detection limit, and therefore, precise estimates of means and standard deviation are not possible. Ignoring all < DL values would give a biased overestimate of the mean and a biased underestimate of the standard deviation and hence, values have to be assigned to all data including < DL values.

The document "The Methods of Analyzing Less Than Detection Limit Data"[3] lists eight methods including maximum likelihood and log regression for handling the < DL data.

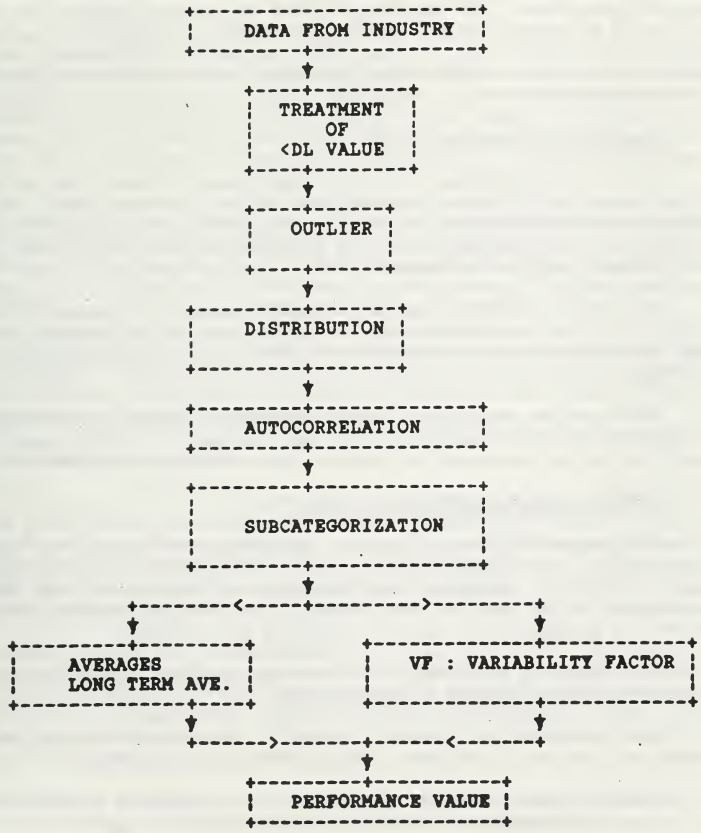
Initial review of the petroleum data reveals that for a large number of parameters all observations are below < DL, and therefore, the use of the maximum likelihood method is not possible in those cases because it requires that at least one observation be above method detection limit. In addition, as most private laboratories doing MISA analysis have different lab detection limits for the same compound, additional complications in using maximum likelihood method can be expected.

For the log regression method, when high rate of censoring occurs (at least 2 values > DL are required), the predicted < DL values would be based on a few observations above the detection limit. This may result in unreliable estimates.

The EPA approach based on the delta lognormal distribution is assessed to be most satisfactory. The delta lognormal distribution is expressed as a mixture of the lognormal distribution for concentration values greater than a censoring value D and a point distribution at D for concentration values less than D. The model, takes care of the lognormal nature of effluent data and the uncertainty of values at < DL level.

FIGURE 1

DATA FLOW CHART



In this approach a fixed censoring point, to handle the less than detection limit data, is required to follow the delta lognormal distribution theory.

Acceptance of the EPA method would require that all values reported below the detection limit be replaced by their nominal method detection limit also called the analytical minimum level. The quantitative value of the analytical minimum level should be 1/10-th of the regulation method detection limit (RMDL), i.e. RMDL/10. The value of RMDL/10, the smallest value a lab can detect, provides a fixed censoring point for calculating averages and variability factors in the delta lognormal distribution, shown step by step in Appendix B.

Data Editing: Treatment of Outliers

There is a strong likelihood of observing many extreme or outlier values as a result of plant upsets, QA/QC problems, sampling errors, or due to unknown causes. As these values may be nonrepresentative of normal operating conditions of the plant, they should be considered for exclusion from the data set to be used for limits. However, the original data base should be reported as received.

The detection of outliers should be performed by statistical tests (examples 2 and 3, Appendix E). If the concentration values are randomly distributed as lognormal, then the outlier test suitable for normally distributed data can be used on natural logarithms of the observations.

The outliers may be indicative of other environmental problems requiring resolution and therefore may require thorough scrutiny before deleting. The outlier values finally deleted from the data set may still be included in reports released to the public.

Confirmation of the Distribution of the Data

An important step in data analysis is characterizing the distribution of chemical concentrations. This is because analysis require the assumptions of constancy of error variance, normality of distribution, and independence of observations. All chemical concentrations for each plant for which effluent limits would be determined should be subjected to a goodness of fit procedure to characterize their distribution.

If distribution is not normal then corresponding analysis suitable for lognormal distribution (example 4, Appendix E) should be used.

The Shapiro-Wilk test is one for normality and the Kolmogorov-Smirnov test is a goodness of fit test for any distribution. EPA uses the studentized range test.

If the data appears to be bimodal, the nature of the distribution around each mode may be considered separately and corresponding analysis carried out.

Test for Autocorrelation

For observations measured daily, there is a likelihood of correlation between them. The effect of this correlation called autocorrelation should be removed from the data before doing further analysis.

Accounting for Autocorrelation

For observations measured on adjacent days, there is a strong likelihood of autocorrelation between them. This increases the estimate of variance of the mean when the autocorrelation is positive (usual case in environment data). Estimates of effluent limits for the mean which is derived using the variance of the mean is affected indirectly even though the mean is not affected. Hence there is a need to take autocorrelation into account.

Calculation of autocorrelation involves analysis of data collected over successive days for each pollutant and estimating the lag-1 autocorrelation (correlation between measurements of two consecutive days). Not all plants would have daily measurements for calculation of autocorrelation and for these plants the average over all the plants could be used. The EPA estimated the lag-1 autocorrelation in this manner [2].

The primary purpose of monitoring data analysis is to set performance values and ensure compliance. Data from BAT plants are analyzed and if the treatment system is operating normally as BAT implies, then effluent concentrations are not expected to have a trend, and therefore de-trending the data is not required.

Subcategorization Analysis

There may be a need to subcategorize an industrial sector into smaller homogeneous subgroups so that plants having similar wastewater characteristics can be treated similarly in terms of uniform effluent performance values. The qualitative and quantitative characteristics of the effluents are dependent on the manufacturing processes, and therefore, it becomes important to group similar types of effluents so that one set of effluent limits can be developed for each type.

Important factors for subcategorization could be: age of the plant, influent wastewater characteristics, water use, flow, products manufactured, production processes, etc. Engineering and best professional judgement could be used for subcategorization. For confirmation, the analysis should ensure that proposed subcategories would show homogeneity of means and variances. This may be achieved by using statistical techniques such as analysis of variance and regression analysis.

The statistical models used for subcategorization are based on analysis of variance and covariance techniques supplemented by mean and variance comparison tests.

EPA uses best engineering and professional judgement for subcategorization.

For confirmation, the dependent variables may be Total Suspended Solids (TSS), Volatile Suspended Solids, Biological Oxygen Demand (BOD) and Phenolic compounds, etc.

Statistical tests that should be used to confirm subcategorization are:

- Bartlett's test for equality of variances.
- The one way analysis of variance supplemented by mean comparison test to form homogeneous sub-groups at significance level 0.05.
- The analysis of covariance when both continuous and discrete independent variables are included in the model.

Estimation of Averages and Loadings

For concentrations, flows, loadings, random flows, nonrandom concentration values, the averages are required to set effluent performance values and to assess the compliance. Improper estimates would result in setting up of wrong performance values and hence good estimates would have to be obtained. Among the averages considered were the arithmetic mean, geometric mean and the median. The arithmetic mean is appropriate, as it is simple, unbiased, takes all observations into account and for compliance purposes it should take care of extreme values also. The EPA uses the arithmetic mean.

Estimation of pollutant loadings are usually done by multiplying the flow by the chemical concentration values. That is, if f_i, c_i and l_i are the flow, concentration, and load on day i, i = 1,2,...,n, respectively then $l_i = f_i * c_i$. The two estimates that could be considered are:

L_1 = Arithmetic mean of Load = (sum of l_i/n)

L_2 = Arithmetic mean of flow * Arithmetic mean of conc. = (sum of f_i/n) * (sum of c_i/n).

Both give unbiased estimates of mean load if flow and concentration are not correlated but if they are correlated L_2 is biased. Thus L_1 is appropriate.

However, as flows are measured on a daily basis, the concentration may not be available everyday or collected in a nonrandom order. Let S be the set of days when both concentration and flow measurements are available. The loading in S is calculated as earlier.

Estimates that could be considered are:

L_3 = Arithmetic mean of loadings over S.

L_4 = Ratio estimator adjusted for bias.

L_4 is optimal when concentration is inversely proportional to the flow. However concentration is not generally inversely proportional to flow. Thus L_3 is recommended.

EPA does not calculate loadings directly for the OCPSF sector. In other sectors the arithmetic mean of loadings is used.

Variability Analysis and Setting of Performance Values

Variability Analysis

The treatment system of better than average plants should be able to meet the Long Term Average (LTA) on an average basis, but would still show variability on a daily or monthly basis. Therefore an accurate estimate of this variability is essential to develop realistic effluent concentration limit guidelines. A plant should be able to comply with the daily and monthly limitations under normal operating conditions.

EPA developed variability factors, which are the ratio of either the 95th or 99th percentile to the mean, to take into account this variability or uncertainty in the effluent pollutant concentrations around the LTA[2]. It is therefore a measure of extreme effluent concentration levels compared to the mean concentration values.

EPA calculated these variability factors for daily maximum VF(1), 30-day mean VF(30) for conventional pollutants, and monthly mean VF(4) for trace organic pollutants. The variability factors thus calculated are unitless and can be averaged across all plants within a production subcategory to yield a subcategory specific variability factor for a pollutant of interest.

Estimation of Long Term Averages

A long term average is necessary to set compliance limits and hence a good estimate of it is required.

A large number of observations per pollutants would provide a representative data base encompassing all sources of variability. A long term average based on these data can be assumed to be an unbiased estimate of the population mean.

The arithmetic mean of the edited data is appropriate (example 5, Appendix E). EPA uses a weighted mean to take into account the non-detects. The arithmetic mean of the edited data is very similar.

Setting of Performance Values

The performance limit for a subcategory should be set as the product of the subcategory LTA and the subcategory variability factor. One of the major advantages of using an EPA based approach is that effluent limits are set as never to exceed values. This would require the industry to adopt a treatment system that would consistently meet the proposed effluent limit guidelines.

A possible alternative to the EPA limit of average LTA * average variability factor is the 99-th percentile (P99). However, performance values should be set around the average long term average of BAT plants, so that in the long run BAT plants would meet at least this average LTA. If not, the plant may have to control their process to meet this average.

Including an allowance for variability in the ministry's limitations is to reflect a facility's normal operation variation. To meet the limitations, plants may have to control within plant variability to the levels exhibited by average BAT plants. Setting the performance value as the product of the average LTA of BAT plants and the average variability factor of BAT plants should meet the above objectives.

For a single plant, P99 = LTA * VF if LTA = mean, but the LTA is not equal to the estimate of the mean E(X) for lognormal data (X). As seen from examples 5 and 7 (Appendix E), LTA is smaller than the estimate of E(X) - generally expected as this estimate is biased upwards where as LTA is unbiased[4]. P99 would give a larger performance value.

For several plants in a category, besides the above reason, the alternative of using the average of the 99-th percentile for setting performance value could give larger performance values especially when there is positive correlation between LTA's and variability factors. Positive correlation could be expected in BAT plants - plants with low LTA's are associated with lower variability factors. Hence average LTA * average variability factor is preferable as performance value.

Three possible options for calculation of performance values (limits) for loadings are as follows:

1. $Limit_1 = (LTA_F \times VF_F) \times (LTA_C \times VF_C)$

2. $Limit_2 = LTA_F \times (LTA_C \times VF_C)$

3. $Limit_3 = LTA_L \times VF_L$

It is shown in Appendix F that $Limit_1$ is biased upwards and $Limit_2$ is biased downward while $Limit_3$ is unbiased and hence $Limit_3$ is recommended .

Appendix B outlines the methods of calculation of variability factors. Example 7 (Appendix E) describes calculation of variability factors for the three distributions: lognormal, delta lognormal and normal. Example 8 (Appendix E) describes calculation of performance limits.

Reporting of Monitoring Data to the Public

Monitoring data would have to be reported for the public to be aware of the discharges by the industries. Reporting 0 for < DL values would give the impression to the public that the actual discharge is 0 and value = DL may give the impression that the actual discharge is = DL. As the true value is between 0 and DL, it is better to report the value as a range.

Data containing values less than RMDL should be reported as follows:

- for data below RMDL, a range (0 and RMDL) should be used to estimate and report averages of concentrations and loadings. The relative number of values above the RMDL may be provided;
- data equal to or greater than RMDL should be reported as found in the data base;
- where applicable, intake data may be reported alongside effluent data.

Typical applications are illustrated by example 1 in Appendix E.

Use of Non-MISA Data

While it is generally assumed that data obtained under the monitoring regulations would be used for setting performance values, it may be necessary, when no plants in Ontario are found to have BAT, to use non-MISA data for setting of some performance values. Non-Misa data would have to meet the criteria outlined in Appendix D before they could be used.

RECOMMENDATIONS

The following are the recommendations of the Issue Resolution Committee on Monitoring Data Analysis:

General Data Analysis

- The data should be analyzed on a plant-by-plant basis.

- Procedure for statistical computations:
  - The entire data set should be characterized for normality first, using approved statistical methods

  - Then certain pieces of raw data should be considered for deletion based on:
    - Identification of outliers as per outlier tests
    - Questionable data as identified by MISA data entry system (MIDES) tags (Appendix A).

- Confirmation of the Distribution of the Data
  - Shapiro-Wilk[8] test for sample size < 50
  - Kolmogorov-Smirnov[7] test for sample size $\geq$ 50
  - If normality is rejected, then the natural logarithm transformation should be applied and tested for normality of the transformed variable.

- Methods for treatment of outliers *(NOTE: Certain data should be considered for deletion as outliers only during limit setting; this is done to ensure that the limits reflect a homogeneous data set. Data deletion will not be done during compliance assessment)*:
  - Box-plot for preliminary screening
  - Dixon's test[5] for sample size < 25
  - Studentized residual test at significance level of 0.05[6] for sample size $\geq$ 25.

- Method for treatment of non-detected (<DL) values
  For statistical computations, the < DL data should be handled as follows:
    - For averages, setting of performance values, and compliance, less than detected values should be replaced by RMDL/10 when these are less than RMDL/10, and when these are greater than or equal to RMDL/10, the value as reported should be used *(NOTE: RMDL is the abbreviation for Regulation Method Detection Limit)*.

- Autocorrelation should be tested by the Durbin-Watson test for normal distributions[6].

- Accounting for Autocorrelation
  - The variance of the mean should be adjusted by a factor involving the autocorrelation estimate and sample size[2].

If X is normal with parameters μ and σ and lag-1 autocorrelation p, the variance of the sample mean X is given by:

$$\text{Var}(\bar{X}) = (\sigma^2/n)[1 + (2/n)\ \Sigma_{k=1}^{n-1}(n - k)p^k].$$

If X is lognormal, that is Y = log X is normal with parameters μ and σ and lag-1 autocorrelation p, the variance of the sample mean of X is given by

$$\text{Var}(\bar{X}) = (1/n)\ \text{Var}(X)f_n(p)$$

where:

$$\text{Var}(X) = \exp(2\mu + \sigma^2)[\exp(\sigma^2) - 1]$$

$$f_n(p) = 1 + [(2/n)\Sigma_{k=1}^{n-1}(n - k)\{\exp(p^k\sigma^2) - 1\}/\{\exp(\sigma^2) - 1\}].$$

- Sub-categorization Analysis
  - Statistical tests for establishing sub-categories are:
    - Bartlett's test[6] for equality of variances
    - One way analysis of variance supplemented by mean comparison test to form homogeneous sub-groups at 0.05 significance level
    - Analysis of covariance when both continuous and discrete independent variables are included in the model.
  - In addition, sector specialists can use best professional judgement (BPJ) to establish sub-categories; the factors that should be considered can include differences in production processes, raw materials, and the like.

- Estimation of Averages and Loadings
  - For the calculation of averages of concentrations and flows, the arithmetic mean should be used
  - For the calculation of averages of loadings, the loading value should be calculated as the product of concentration and corresponding flow values. The arithmetic mean of all available loading values should be calculated as the average, that is, L_1 when concentration values are available corresponding to every flow measurement and L_3 when concentration values are not available corresponding to every flow measurement (example 6 in Appendix E).

Variability Factor Analysis and Setting of Performance Values

- Variability Analysis
  - The daily and monthly variability factors (VF) should be calculated as:

- Daily maximum: VF(daily) = 99th percentile* concentration from the distribution of daily samples/mean *(*or the percentile as finally defined under the issue of Limit Setting and Form of Limits)*
- Monthly: VF(n) = 95th percentile* concentration from the distibution of monthly average samples/mean, where "n" equals the number of sampling days in the month.

- In the calculation of VF(30), autocorrelation among observations should be taken into account by using the adjusted variance given above under Accounting for Autocorrelation.

- Estimation of Long Term Averages (LTA)
  - For plant long term averages for concentrations and loadings, the arithmetic mean of all edited (as per outlier tests, treatment of <DL values, etc.) concentration values and loading values, respectively, should be used

- Setting of Performance Values
  - The performance values (PF) should be calculated by multiplying the variability factor (VF) by the long term average (LTA).

The expressions for calculating the various variability factors for delta-lognormal data (lognormal data would be a special case of this when delta = 0) and normal data are given in Appendix B. An example (No. 7) is given in Appendix E.

Reporting Data to the Public

- Data containing < DL values should be reported as follows:
  - For data below RMDL, a range (0 and RMDL) should be used to estimate and report averages of concentrations and loadings. The relative number of values above the RMDL may be provided
  - Data equal to or greater than RMDL should be reported as found in the data base
  - Wherever applicable, intake data alongside effluent data may be reported.

Use of Non-MISA Data

- Non-MISA data may be used when necessary, provided it meets the criteria outlined in Appendix D of the Issue Resolution Committee Report on Monitoring Data Analysis.

UNRESOLVED CONCERNS

None.

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APPENDIX A

Consider for deletion of raw data:

Data identified with the following MISA data entry system (MIDES) tags may require further scrutiny to determine if it should be deleted:

?	IB	SD	UQC
!	IC	SID	USD
AIS	IM	SIP	
AR	MP	UCR	
I	O	UNF	

code	Description
?	Late data: data yet available
!	No data will be reported
AIS	Approximate value insufficient sample
AR	Attached report
I	Interference suspected
IB	Interference background
IC	Interference colour
IM	Interference sample matrix
MP	Multiphase sample: result may be suspect
O	Old: sample exceeds maximum storage time
SD	Sample duplicates differ in appearance
SID	Sample identification questionable
SIP	Sample improperly preserved
UCR	Data unreliable: could not confirm by reanalysis
UNF	Data unreliable: container not filled to top
UQC	Data unreliable: possible lab QC problem(s)
USD	Data unreliable: sample decomposition noted.

APPENDIX B

DELTA-LOGNORMAL DATA (lognormal data follows as a special case)

CALCULATION OF VARIABILITY FACTOR VF(1)

Let $X_1, X_2, \ldots, X_r$ be observations that are non-detects and $X_{r+1}, X_{r+2}, \ldots, X_n$ be observations that are detects.

The sample mean (m) and sample standard variance (s^2) of the transformed variables are given by:

$$m = \frac{\sum_{i=r+1}^{n} \ln (X_i)}{n - r}$$

$$s^2 = \frac{\sum_{i=r+1}^{n} [\ln (X_i) - m]^2}{n - r - 1}$$

where r = total no. of non-detects and n = total no. of observations. The censoring point (D), the proportion of non-detects (DELTA) and the daily variability factor (VF(1)) are:

$$D = RMDL/10$$

$$DELTA\ (DEL) = \frac{\#\ of\ non\text{-}detects}{\#\ of\ observations}$$

$$VF(1) = \frac{99th\ Percentile\ (P99)}{E(X)}$$

$$E(X) = DEL * D + (1- DEL)* \exp(m + 0.5 * s^2)$$

$$P99 = \begin{cases} D, & \text{IF DEL} >= .99 \\ \text{Max } [D, \exp(m + Z * s)], & \text{otherwise} \end{cases}$$

where $Z = \phi^{-1} [(.99 - DEL)/(1 - DEL)]$ and

$\phi(x)$ is the distribution function of the standard normal distribution and s the standard deviation.

For lognormal data DEL = 0 in above expressions.

CALCULATION OF VARIABILITY FACTOR VF(4)

The monthly 4-day variability factor ((VF(4)) is

$$VF(4) = \frac{95\text{th Percentile (P95)}}{E(X)}$$

$$V(X) = (1- DEL) * \exp(2m + s^2) * [\exp(s^2) -1 + DEL] + DEL * (1- DEL) * D * [D -2 * \exp(m + 0.5 * s^2)]$$

Let $K = E(X) - DEL^4 * D$

$$P95 = \begin{cases} D, \text{ IF } DEL^4 >= 0.95 \\ MAX\ (D, \exp(m4 + Z4 * s4^{0.5})), \text{ otherwise} \end{cases}$$

where

$$s4 = Ln\ \{(1 - DEL^4)[1 + V(X)/(4K^2) - DEL^4 * (1 - DEL^4) * D^2/K^2 + 2 * DEL^4 * D/K]\}$$

$$m4 = Ln\ [K/(1 - DEL^4)] -0.5 * s4$$

$$Z4 = \phi^{-1}\ [(.95 - DEL^4)/(1 - DEL^4)]$$

(Note that s4 corresponds to s^2 in expressions for daily variability.)

For lognormal data DEL = 0 in above expressions.

CALCULATION OF VARIABILITY FACTOR VF(30)

Since the 30-day mean $\bar{X}_{30}$ is approximately normally distributed by the Central Limit Theorem, the approximate estimates of the 95th percentile and the 30-day variability factor (VF(30)) are given by

$$E(\bar{X}_{30}) = \exp(m + 0.5 * s^2)$$

$$Var(\bar{X}_{30}) = \frac{V(X)}{30} * f_{30}(p)$$

where:

$$m = \frac{\Sigma_{i=1}^{n} \ln (X_i)}{n}$$

$$s^2 = \frac{\Sigma_{i=1}^{n}[\ln (X_i) - m]^2}{n - 1}$$

$$P95 = E(\bar{X}_{30}) + 1.645 * (V(\bar{X}_{30}))^{0.5}$$

and

$$VF(30) = P95/E(\bar{X}_{30})$$

$$= 1 + 1.645 * [(\exp(s^2) - 1) * f_{30}(p)/30]^{0.5}$$

where

$$f_n(p) = 1 + [(2/n)\Sigma^{n-1}_{k=1}(n - k)\{\exp(p^k s^2) - 1\}/\{\exp(s^2) - 1\}]$$

p = lag-1 autocorrelation of ln (X)

NORMAL DATA: all values are detected

Let

m = E(X) = Arithmetic Mean of X and

s = Standard Deviation of X, then

$$P99 = m + s * 2.326, \text{ where } 2.326 = \phi^{-1}(.99)$$

$$VF(1) = P99/E(X).$$

For 4-day monthly variability factor

$$P95 = m + 1.645 * s/2, \text{ where } 1.645 = \phi^{-1}(.95).$$

$$VF(4) = P95/E(X)$$

For the 30-day variability factor

$$VF(30) = P95/E(\bar{X}_{30}), \text{ where } E(\bar{X}_{30}) = m, \text{ and}$$

$$P95 = m + 1.645 * [(s^2/30) * \{1 + (2/30) * \Sigma^{29}_{k=1}(30 - k) * p^k\}]^{0.5}$$

where p is the lag-1 autocorrelation.

NORMAL DATA: some values are non-detects

CALCULATION OF VARIABILITY FACTORS FOR DELTA NORMAL DISTRIBUTION

Let m and s be the mean and std.dev. of values > DL.

$$\delta = \frac{\text{number of non-detects}}{\text{total number of data}}$$

$D = RMDL/10$

$E(X) = \delta * D + (1 - \delta) * m$

$VAR(X) = (1 - \delta) * s^2 + \delta * (1 - \delta) * (D - m)^2$

$$P99 = \begin{cases} D, & \text{IF } \delta >= .99 \\ \text{Max}(D,\ m + s * Z), & \text{otherwise} \end{cases}$$

where $Z = \phi^{-1}\ [(.99 - \delta)/(1 - \delta)]$

$$VF(1) = \frac{P99}{E(X)}$$

CALCULATION OF VF(4)

Following the same procedure as in the lognormal distribution:

$E(\bar{X}) = \delta^4 * D + (1 - \delta^4) * m4$

$VAR(\bar{X}) = (1 - \delta^4) * s4 + \delta^4 * (1 - \delta^4) * (D - m4)^2$

$$P95 = \begin{cases} D, & \text{IF } \delta^4 >= .95 \\ \text{MAX}(D,\ m4 + Z4 * (s4)^{0.5}), & \text{otherwise} \end{cases}$$

$Z4 = \phi^{-1}\ [(.95 - \delta^4)/(1 - \delta^4)]$

Note s4 corresponds to the variance s^2 of X (>DL).

From these three equations, using also the fact that

$E(\bar{X}) = E(X)$, AND $VAR(\bar{X}) = VAR(X)/4$

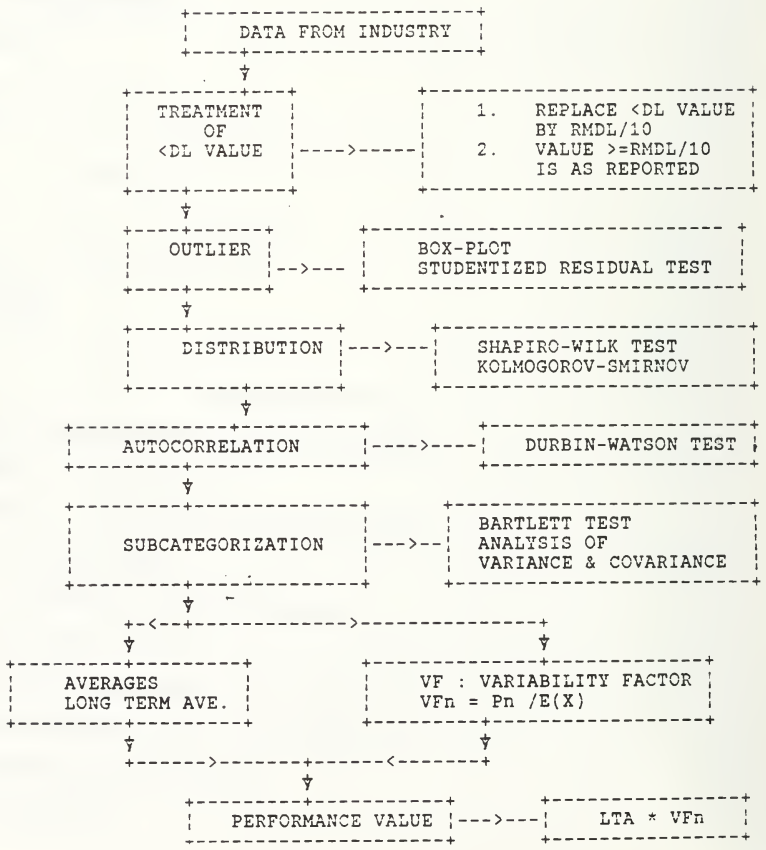
$m4 = [E(X) - \delta^4]/(1 - \delta^4)$

$$(1 - \delta^4) * s4 + \delta^4 * (1 - \delta^4) * (D - m4)^2 = (1/4) * VAR(X)$$

$$s4 = [(1/4) * VAR(X)/(1 - \delta^4)] - \delta^4 * (D - m4)^4$$

APPENDIX C

FIGURE 1: DATA FLOW AND ANALYSIS CHART



APPENDIX D

CRITERIA FOR USE OF NON-MISA DATA

Non-MISA data will have to meet the following criteria before they could be used:

(i) Lab Method Detection Limit of non-MISA data is comparable to MOE RMDL.

(ii) Equivalent field or lab QA/QC procedures.

(iii) Accuracy of analysis should be traceable to reference material and/or supported by inter-lab studies.

(iv) Analytical and sampling protocols should be comparable to those in MISA Effluent Monitoring Regulations.

(v) Flow accuracy, if required, should be comparable to that in MISA Effluent Monitoring Regulations.

(vi) Preference will be given to data collected within the last five years.

(vii) MOE's ability to access the raw data base to assess its quality will be desirable.

APPENDIX E

In the following examples a typical data base is used to illustrate:

Example 1. Data Editing and Reporting

Example 2. Dixon's Test for Outliers

Example 3. Studentized Residual Test for Outliers

Example 4. Tests for Data Distribution and Autocorrelation

Example 5. Calculation of Averages

Example 6. Calculation of Loading Means

Example 7. Calculation of Variability Factors

Example 8. Calculation of Performance Values

Example 1. Data Editing and Reporting

The data in terms of concentration (C) of a pollutant in a single plant are edited for analysis and reported to the public as follows; RMDL = 5 ug/l, RMDL/10 = 0.5 ug/l, exact value of LMDL not available in MIDES data base.

OBS	RAW (ug/l)	EDIT (ug/l)	CALCULATION (ug/l)	
1	4.0 < DL	4.0	0	5
2	57.0	57.0	57	57
3	13.0	13.0	13	13
4	0.2 < DL	0.5	0	5
5	0.3 < DL	0.5	0	5
6	6.0	6.0	6	6
7	20.0	20.0	20	20
8	10.0	10.0	10	10
9	22.0	22.0	22	22
10	0.6 < DL	0.6	0	5
11	2.0 < DL	2.0	0	5
12	0.8 < DL	0.8	0	5
13	17.0	17.0	17	17
14	11.0	11.0	11	11
15	4.0 < DL	4.0	0	5
16	7.0	7.0	7	7
17	4.0 < DL	4.0	0	5
18	6.0	6.0	6	6
19	13.0	13.0	13	13
20	15.0	15.0	15	15
21	7.0	7.0	7	7
22	0.8 < DL	0.8	0	5
23	12.0	12.0	12	12
24	2.0 < DL	2.0	0	5
25	44.0	44.0	44	44
26	2.0 < DL	2.0	0	5
27	31.0	31.0	31	31
28	0.2 < DL	0.5	0	5
29	0.4 < DL	0.5	0	5
30	57.0	57.0	57	57
31	25.0	25.0	25	25
Average	12.719	12.748	12.032	14.129
Report to public	12.7	12.7	12.0	14.1

Taking < DL values = 0 , average = 12.0
Taking < DL values = DL, average = 14.1
The relative number of data above RMDL = 18/31 = 58%.

Example 2. Dixon's Test for Outliers

Since Dixon's test is applicable to less than 25 observations, 23 edited values of C from example 1 were selected (selected values (X)) to illustrate this test. The values are first ordered. X_i is the ordered observation.

OBS	X
1	0.5
2	0.6
3	0.8
4	2.0
5	2.0
6	4.0
7	4.0
8	6.0
9	6.0
10	7.0
11	10.0
12	11.0
13	13.0
14	13.0
15	15.0
16	17.0
17	20.0
18	22.0
19	25.0
20	31.0
21	44.0
22	57.0
23	57.0

For X_{23}, the Dixon's coefficient r is given by (4)

$r = (X_{23} - X_{21}) / (X_{23} - X_3) = (57 - 44) (57 - 0.8)$

$= .23$

From Dixon's tables this is not significant at level 0.95 and X_{23} is not an outlier.

Similarly for X_1, $r = (X_3 - X_1) / (X_{21} - X_1) = 0.007$ and from Dixons's tables, X_1 is not an outlier.

Example 3. Studentized Residual Test for Outliers

For the edited data of example 1,

DEV. = conc. - mean conc.

STUD. = Studentized Residual = DEV/[std.dev * $\{1 - (1/31)\}^{0.5}$]

OBS	Conc.	DEV.	STUD.
1	4.0	-8.7	-0.57
2	57.0	44.3	2.88*
3	13.0	0.3	0.02
4	0.5	-12.2	-0.80
5	0.5	-12.2	-0.80
6	6.0	-6.7	-0.44
7	20.0	7.3	0.47
8	10.0	-2.7	-0.18
9	22.0	9.3	0.60
10	0.6	-12.1	-0.79
11	2.0	-10.7	-0.70
12	0.8	-11.9	-0.77
13	17.0	4.3	0.28
14	11.0	-1.7	-0.11
15	4.0	-8.7	-0.57
16	7.0	-5.7	-0.37
17	4.0	-8.7	-0.57
18	6.0	-6.7	-0.44
19	13.0	0.3	0.02
20	15.0	2.3	0.15
21	7.0	-5.7	-0.37
22	0.8	-11.9	-0.78
23	12.0	-0.7	-0.05
24	2.0	-10.7	-0.70
25	44.0	31.3	2.03*
26	2.0	-10.7	-0.70
27	31.0	18.3	1.19
28	0.5	-12.2	-0.80
29	0.5	-12.2	-0.80
30	57.0	44.3	2.88*
31	25.0	12.3	0.79

N Obs	Std. Dev.
31	15.616

* consideration as outlier ($Z_{97.5}$ = 1.96). Z is the standard normal deviate.

Example 4. Tests for Data Distribution and Autocorrelation

For the data of example 1, the Shapiro-Wilk statistic for the edited data is 0.757 and p-value is 0.0001 and hence normality is rejected. The Shapiro-Wilk statistic of ln C (values > RMDL/10) is 0.96 and p-value is 0.37. Lognormality is not rejected.

Taking the observations in example 1 as taken over consecutive days the Durbin Watson statistic = 1.977 which is greater than the upper value 1.47 (from Durbin Watson tables) at level 0.05 for n = 27 and hence autocorrelation = 0 is not rejected.

Example 5. Calculation of Averages

For the data of example 1 (RMDL = 5)

OBS	CONC	EDIT (X)	Ln C (Y)
1	4.0	4.0	1.38629
2	57.0	57.0	4.04305
3	13.0	13.0	2.56495
4	0.2	0.5	.
5	0.3	0.5	.
6	6.0	6.0	1.79176
7	20.0	20.0	2.99573
8	10.0	10.0	2.30259
9	22.0	22.0	3.09104
10	0.6	0.6	-0.51083
11	2.0	2.0	0.69315
12	0.8	0.8	-0.22314
13	17.0	17.0	2.83321
14	11.0	11.0	2.39790
15	4.0	4.0	1.38629
16	7.0	7.0	1.94591
17	4.0	4.0	1.38629
18	6.0	6.0	1.79176
19	13.0	13.0	2.56495
20	15.0	15.0	2.70805
21	7.0	7.0	1.94591
22	0.8	0.8	-0.22314
23	12.0	12.0	2.48491
24	2.0	2.0	0.69315
25	44.0	44.0	3.78419
26	2.0	2.0	0.69315
27	31.0	31.0	3.43399
28	0.2	0.5	.
29	0.4	0.5	.
30	57.0	57.0	4.04305
31	25.0	25.0	3.21888

$$m_Y = \frac{\Sigma_{i=1}^{N} Y_i}{N} = 2.045, \qquad m_X = \frac{\Sigma_{i=1}^{N} X_i}{N} = 12.748$$

$$s^2_Y = \frac{\Sigma_{i=1}^{N} (Y_i - m_y)^2}{N-1} = 1.617$$

N Obs	Variable	Mean	Std Dev
27	Ln C (Y)	2.045	1.272
31	Edit C (X)	12.748	15.615
31	C	12.719	15.639

Long term average of concentration (mean edit C) = 12.75 ug/l

Example 6. Calculation of Loading Means

For the data of flow and concentration (from example 1) given below loadings and the loading mean are calculated.

Flow is measured in million litres per day (mld)

OBS	Edit C (ug/L)	Flow (F) (mld)	Load (L) flow*conc.
1	4.0	1.58	6.320
2	57.0	1.56	88.920
3	13.0	1.95	25.350
4	0.5	1.47	0.735
5	0.5	1.96	0.980
6	6.0	1.75	10.500
7	20.0	1.50	30.000
8	10.0	1.49	14.900
9	22.0	1.35	29.700
10	0.6	1.46	0.876
11	2.0	1.78	3.560
12	0.8	1.79	1.432
13	17.0	1.34	22.780
14	11.0	1.25	13.750
15	4.0	1.47	5.880
16	7.0	1.56	10.920
17	4.0	1.67	6.680
18	6.0	1.54	9.240
19	13.0	1.32	17.160
20	15.0	1.46	21.900
21	7.0	1.82	12.740
22	0.8	1.47	1.176
23	12.0	1.26	15.120
24	2.0	1.57	3.140
25	44.0	1.38	60.720
26	2.0	1.49	2.980
27	31.0	1.56	48.360
28	0.5	1.48	0.740
29	0.5	1.75	0.875
30	57.0	1.45	82.650
31	25.0	1.49	37.250

Obs	Variable	Mean	Std Dev
31	Edit C	12.748	15.616
	F	1.547	0.184
	L	18.946	23.105

L_1 = Loading mean = 18.946 gms/day

Calculation of loading means (concentration values are not observed on some days when flow values are observed).

For illustration the same data are used with edited concentration values deleted for certain days.

OBS	Edit C (ug/L)	Flow (F) (mld)	Load (L) flow*conc.
1		1.58	
2	57.0	1.56	88.920
3		1.95	
4		1.47	
5		1.96	
6	6.0	1.75	10.500
7		1.50	
8		1.49	
9	22.0	1.35	29.700
10		1.46	
11		1.78	
12	0.8	1.79	1.432
13		1.34	
14	11.0	1.25	13.750
15		1.47	
16		1.56	
17	4.0	1.67	6.680
18		1.54	
19		1.32	
20	15.0	1.46	21.900
21		1.82	
22		1.47	
23	12.0	1.26	15.120
24		1.57	
25	44.0	1.38	60.720
26		1.49	
27		1.56	
28	0.5	1.48	0.740
29		1.75	
30		1.45	
31		1.49	
		Total	259.462
		mean =	25.95

L_3 = Loading mean = 25.95 gms per day

Example 7. Calculation of Variability Factors

For the data in example 4 the variability factors are calculated as follows: (RMDL = 5)

CALCULATION OF VARIABILITY FACTOR VF(1)

n = number of observations = 31

r = number of non-detects = 4

Let

$$m = \frac{\Sigma \ln (C_i)}{n - r} = 2.045$$

$$s^2 = \frac{\Sigma [\ln (C_i) - m]^2}{n - r - 1} = 1.617$$

$$s = 1.272$$

$$D = RMDL/10 = 0.5$$

$$\text{DELTA (DEL)} = \frac{\text{\# of non-detects}}{\text{\# of observations}} = 4/31 = 0.1290$$

$E(C) = DEL * D + (1- DEL)* \exp(m + 0.5 * s^2)$

$= 0.1290 * 0.5 + (1 -.129) * \exp(2.045 + 0.5 *1.617)$

$= 15.185$

$Z = \phi^{-1} [(.99 - DEL)/(1 - DEL)]$

$= \phi^{-1} [(.99 - .129)/(1 - .129)] = 2.274$

$\phi(x)$ is the distribution function of the standard normal distribution.

$$P99 = \begin{cases} D, \text{ IF DEL} >= .99 \\ \text{Max } [D, \exp(m + Z * s)], \text{ otherwise} \end{cases}$$

$= \exp(2.045 + 2.274 * 1.2719)$

$= 139.45$

$$VF(1) = \frac{\text{99 Percentile (P99)}}{E(C)}$$

$$= 139.45/15.185 = 9.18$$

CALCULATION OF VARIABILITY FACTOR VF(4)

$$V(C) = (1- DEL) * \exp(2m + s^2) * [\exp(s^2) -1 + DEL] + DEL * (1- DEL) * D * [D -2 * \exp(m + 0.5 * s^2)]$$

$$= 1092.98$$

Let $K = E(C) - DEL^4 * D = 15.1849$

$$s4 = Ln\ [(1 - DEL^4)[1 + V(C)/(4K^2) - DEL^4 * (1 - DEL^4) * D^2/K^2 + 2 * DEL^4 * D/K]]$$

$$= 0.781$$

$$m4 = Ln\ [K/(1 - DEL^4)] -0.5 * s4 = 2.330$$

$$Z4 = \phi^{-1}\ [(.95 - DEL^4)/(1 - DEL^4)] = 1.6447$$

$$P95 = \begin{cases} D, \text{ IF } DEL^4 >= 0.95 \\ MAX\ (D, \exp(m4 + Z4 * s4^{0.5})), \text{ otherwise} \end{cases}$$

$$= 43.98$$

$$VF(4) = \frac{\text{95 Percentile (P95)}}{E(C)}$$

$$= 43.98/15.185 = 2.90$$

CALCULATION OF VF(30)

For the data of example 1, we noted (in example 4) that there is no autocorrelation. The standard deviation of the natural logarithm of the data is 1.269. Hence

$$f_{30}(p) = 1 \text{ and}$$

$$VF(30) = 1 + 1.645 * [(\exp(s^2) - 1)/30]^{0.5}$$

$$= 1 + 1.645 * [(\exp(1.269^2) - 1)/30]^{0.5}$$

$$= 1.60$$

Example 8. Calculation of Performance Values

For the data of example 1, we have from examples 5 and 7

Long term average (LTA) = 12.75 ug/L
(Since there is only one plant, the average of LTA's = LTA of the single plant)

Variability factor (daily) (VF(1)) = 9.18

The plant performance value (daily) = LTA * VF(1)

= 12.75 * 9.18 = 117.05 ug/L

4-day variability factor VF(4) = 2.90

The plant performance value (4-day) = LTA * VF(4)

= 12.75 * 2.90 = 36.98 ug/L

In example 7 taking autocorrelation = 0, the 30-day variability factor (VF(30)) = 1.60, the long term average of C = 12.75 (example 5).

The plant performance value (30-day) = LTA * VF(30)

= 12.75 * 1.60 = 20.40 ug/L.

APPENDIX F

LOADING PERFORMANCE VALUES

For long term averages of loadings for a plant, the arithmetic mean is appropriate as the number of observations is large. For overall LTA, the mean of these arithmetic means is appropriate as in the case of concentration. Variability factors for loadings can be calculated the same way as for concentrations. For setting the limits for loadings, three possible options for calculation of limits for loadings are as follows:

1. $L_1 = (LTA_F \times VF_F) \times (LTA_C \times VF_C)$

2. $L_2 = LTA_F \times (LTA_C \times VF_C)$

3. $L_3 = LTA_L \times VF_L$

L_1 and L_2 considers flow and concentration values separately ignoring any correlation between flow and concentration measurements. So they may not be appropriate if flow and concentration are correlated. Suppose the flow and concentration are independent. Assuming that load is normally distributed the expected value of the effluent limit for a single plant is (with the usual notation)

$P99 = \mu_L + 2.326 * \sigma_L = \mu_F * \mu_C + 2.326 * \sigma_L$.

$L_3 = m_L + 2.326 * s_L$ where m and s are the estimates of μ and σ.

$E(L_3) = \mu_F * \mu_C + 2.326 * \sigma_L$ and is unbiased.

$E(L_1) = (\mu_F + 2.326 * \sigma_F) * (\mu_C + 2.326 * \sigma_C)$

$= \mu_F * \mu_C + 2.326 * [\sigma_F\mu_C + \sigma_C\mu_F + 2.326 * \sigma_F\sigma_C]$

$E(L_1) - [\mu_F * \mu_C + 2.326 * \sigma_L] = 2.326 * [\sigma_F\mu_C + \sigma_C\mu_F + 2.326 * \sigma_F\sigma_C - \sigma_L]$

Noting that $\sigma_L = [\sigma_F^2\mu_C^2 + \sigma_C^2\mu_F^2 + \sigma_F^2\sigma_C^2]^{0.5}$,

$[\sigma_F\mu_C + \sigma_C\mu_F + 2.326 * \sigma_F\sigma_C]^2 - [\sigma_F^2\mu_C^2 + \sigma_C^2\mu_F^2 + \sigma_F^2\sigma_C^2]$

$= 4.410 * \sigma_F^2\mu_C^2 + 2\sigma_F\mu_C\sigma_C\mu_F + 4.652 * \sigma_F\sigma_C[\sigma_F\mu_C + \sigma_C\mu_F] >= 0$

Hence L_1 is biased positively. Similarly

$E(L_2) = \mu_F * (\mu_C + 2.326 * \sigma_C)$

L_2 is biased negatively. Hence L_3 is preferable.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

SELECTION OF PARAMETERS FOR LIMITS

ISSUE

To provide a procedure for the selection of parameters from those monitored under the MISA Effluent Monitoring Regulation in a way that will allow a list of parameters to be developed for each sector or sub-sector so that the listed parameters can be assessed for BAT(EA) treatability.

BACKGROUND

Scope

Data collected under the MISA Effluent Monitoring Regulations will provide up-to-date information on the presence of priority and conventional pollutant parameters.

The Effluent Monitoring Priority Pollutants List (EMPPL) and the list of conventional and non-conventional parameters served as the basis for the monitoring of some 160 parameters in the effluents of nine industrial sectors under the monitoring regulations. A process is required to screen this data to determine which parameters are relevant to each sector or sub-sector for limit setting based on BAT(EA) treatability.

The main purpose for selection of parameters is to bring forward for each sector or sub-sector a list of parameters to be evaluated for BAT(EA) treatability.

The selection criteria should be linked to the definition of "virtual elimination". The criteria in this would recognize the fact that the parameters under scrutiny vary with respect to their chemical properties, toxicity, and environmental fate.

The recommendation for the selection of parameters should adopt a conservative selection approach which would allow parameters which are clearly demonstrated to be absent from sector or sub-sector effluents to be omitted from the selection list.

The administration, monitoring requirements, and compliance with the effluent limits, will be capital and resource intensive. It is therefore, desirable to ensure that a minimum number of parameters are selected, without sacrificing the integrity of the program in terms of environmental control.

It is intended that limits will be considered only for those parameters which are treated by the technology determined to be BAT(EA) for a particular sector or sub-sector. The assessment of treatability has been recommended by the Issue Resolution Committee on Best Available Technology. If no treatment is identified under BAT(EA), those parameters would be subject to monitoring, as proposed by the Issue Resolution Committee on Monitoring Frequency for Assessment. However, parameters of environmental significance, which are not selected according to the criteria proposed, may also be considered for selection through Best Professional Judgement (BPJ).

U.S. EPA Approach

Under the Clean Water Act of 1977, the EPA was required to regulate a list of 129 Priority Pollutants. Under paragraph eight of the 1976 Natural Resources Defense Council Consent Decree (NRDC), the EPA was given the authorization to add or remove specific pollutants from a category or subcategory of point sources.

The EPA used the results from questionnaires, subcategorization and field sampling exercises to determine which toxic pollutants were found in significant quantities in discharges from the industry. Untreated wastewaters from product/process lines most common in the industry were tested for conventional parameters and 126 priority pollutants[1].

Each pollutant was assessed according to the following criteria:

- occurrence of pollutants in a plant's raw waste
- effectiveness of in-place treatment to control pollutants in the raw wastewater
- observed pollutant load in relation to actual plant operations.

Other considerations included whether the plant uses toxic pollutants as a raw material or as a by-product of the manufacturing process.

Under paragraph 8, of the NRDC settlement, the EPA was given authorization to exclude parameters from regulation on any one of the following grounds;

1) not detectable by state of the art methods,
2) present in amounts too small to be effectively reduced by available technologies,
3) present only in trace amounts and neither causing nor likely to cause toxic effects,
4) detected in the effluent from only a small number of sources within a subcategory and uniquely related to only those sources,
5) will be effectively controlled by technologies which are based on other effluent limitations, or,
6) are toxic pollutants for which more stringent protection is provided under section 307(a) of the act.

These general rules were applied to parameter selection for all point source category limitations promulgated after passing of the Clean Water Act[2].

DISCUSSION

Data Base

Effluents were characterized for parameters on the Effluent Monitoring Priority Pollutants List (EMPPL)[3] and a specified list of conventional and non-conventional parameters. Although some upstream data were included, most effluents were monitored at end-of-pipe.

The data base was generated using pre-defined analytical methods and QA/QC protocol. It includes routine monitoring (i.e. daily, thrice weekly, weekly and monthly), characterizations, as well as open scans. Open scans will not be used as the sole source of data for selection of a parameter.

Prior to initiating the process for parameter selection, each plant/process within a sector should be organized into a homogeneous group to ensure that plant sites or facilities with similar characteristics are treated uniformly in terms of limits. The factors to be considered for this categorization process are discussed in the Final Report of the Issue Resolution Committee on Best Available Technology.

Within each homogeneous group, edited (as per outlier tests, treatment of <DL values, etc.) data from each plant would be further classified according to effluent stream type (e.g. process, cooling water etc.). This would ensure that the parameters selected are relevant to a particular stream type.

Procedure for Parameter Selection

A number of statistical approaches were evaluated for developing a selected list of parameters to be assessed for treatability by BAT(EA).

The preferred approach consists of analysis of the data for each plant with the result totalled for the corresponding sector/sub-sector and stream type grouping. If data are pooled prior to analysis, valuable trends or conclusions could be missed which would otherwise have shown up if a smaller set of data had been analyzed. This plant-by-plant approach would be applied in the interest of identifying a list of parameters which best represent the sector or sub-sector on an all encompassing basis.

Since treated effluent data are being analyzed, it is critical to maintain a conservative approach in selecting parameters for BAT(EA) review.

Each data set would be subjected to statistical analyses to determine the frequency of occurrence for each parameter. Frequency of occurrence would be tabulated based on the number of times a parameter is found above a trigger.

The selection process would include every substance that was monitored unless a statistically determined 0.90 proportion of the data set was less than the trigger value for that substance at 95% confidence level.

The critical numbers to demonstrate that 0.90 of a data set is less than the specified trigger for a given sample size are shown in the table below. Substances found infrequently, that is, not meeting the 0.90 criterion, would not be promoted for BAT(EA) review.

TABLE 1. Critical Test Values for Selection
(0.90 Proportion of Data at a 95% confidence limit according to Conovor,WJ (4))

SAMPLE FREQUENCY	SAMPLE SIZE	MINIMUM NUMBER OF SAMPLES < TRIGGER FOR EXCLUSION
Daily	365	320
Thrice Weekly	156	135
Weekly	52	44
Monthly	12	9

The trigger for conventional, non-conventional, and non-persistent toxic contaminants should be the Water Quality Objective or Guideline. The trigger for persistent toxic substances should be linked to the definition of Virtual Elimination, since that is the ultimate goal for these compounds.

Since the definition of Virtual Elimination remains unresolved at this time, three types of triggers for the selection of persistent toxic compounds, based on the alternatives presented under the *Unresolved Concerns* in the Final Report of the Issue Resolution Committee on Virtual Elimination, could be considered:

1. **The level of detection as defined by the Regulation Method Detection Limit (RMDL)**
   This type of trigger may allow many substances to be flagged for BAT(EA) treatability and a potential candidate for limits regardless of their impact on the environment. This trigger would provide a conservative approach in selecting parameters for limits.

2. **The Provincial Water Quality Objective or Guideline**
   This type of trigger would promote only those substances that exist in the effluent at levels which may pose adverse impact on the environment.

3. **The level of detection as defined by the Regulation Method Detection Limit (RMDL) for those toxic substances of greatest concern, and the PWQO/G for the remaining toxic substances:**
   Consideration may be given to parameters which have different impacts on the environment by dividing them into two primary groups:
   (A) Persistent and bioaccumulative toxic substances
   (B) Other toxic substances

The RMDL trigger for Group A allows the selection of persistent and bioaccumulative toxic substances. These substances are critical due to their potential threat to the health and productivity of living aquatic resources and human use.

The PWQO/G trigger for Group B would promote only those parameters among toxic substances when they have reached the level that poses a threat to the aquatic environment. Provincial Water Quality Objectives or Guidelines provide the basis for assessing the impact of discharges on surface waters. The factors used to establish PWQO/G take into account:

- Toxicity to aquatic life (acute, chronic, lethal and sublethal)
- Bioaccumulation (human health via fish consumption, wildlife)
- Mutagenicity to aquatic life
- Persistence in the environment

Best Professional Judgement (BPJ) may be used by the JTC (Joint Technical Committee), where appropriate, to remove parameters from the list of those selected, or to add parameters to the list provided sufficient technical justification is provided.

RECOMMENDATIONS

The Issue Resolution Committee on Selection of Parameters for Limits proposes the following:

- The selection process to produce a list of parameters for BAT(EA) screening should be applied to those parameters measured under MISA.

- All analytical data collected under MISA should be analyzed by stream type.

- All persistent toxic contaminants should be included, unless the effluent data satisfies the following criterion: a parameter should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the value defined as virtual elimination (since the definition of virtual elimination is unresolved, there are two options for the selection criteria as stated in the under *Unresolved Concerns* below).

- All non-persistent toxic, conventional, and non-conventional pollutants should be included, unless the effluent data satisfies the following criterion: a parameter should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the Provincial Water Quality Objective for that parameter.

- The sector or sub-sector list should consist of the sum of those parameters selected from each plant within the sector or sub-sector.

- Parameters of environmental significance which are not selected according to the above criteria, may also be considered for selection through Best Professional Judgement (BPJ).

- Selected parameters may be deleted through BPJ, provided detailed justification is given.

UNRESOLVED CONCERNS *(Including Options)*

Selection Criteria for Persistent Toxic Contaminants
(NOTE: Selection criteria for non-persistent toxic, conventional, and non-conventional contaminants are stated above)

Alternative 1:

A persistent toxic contaminant should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the Regulation Method Detection Limit (RMDL).

Alternative 2:

A persistent toxic contaminant should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the Provincial Water Quality Objective (PWQO).

Additional Proposal

This proposal, put forward by some members of the Issue Resolution Committee, is aimed at directing initial control efforts toward those priority contaminants which have the greatest impact on human health and the environment. This is done only for the purpose of selecting parameters for the first Effluent Limits Regulations, and is not linked to the goal of virtual elimination.

Accordingly, an EMPPL parameter which is persistent and bioaccumulative should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the Regulation Method Detection Limit (RMDL). All other EMPPL parameters should be deleted from the data set for selection if the monitoring data show (at a 95% confidence level) that a statistical proportion of 0.9 of the data are at concentrations less than the Provincial Water Quality Objective (PWQO).

REFERENCES

(1) United States Environmental Protection Agency/ Industrial Technology Division, Development Document for Effluent Limitations Guidelines and Standards for the Organic Chemicals, Plastics and Synthetic Fibers Point Source Category. Washington D.C., October 1987 (EPA 440/1-87/009)

(2) Presentation - "U.S. EPA Experience - Development of Effluent Limitations and Guidelines" by Science Applications International Corporation, March 14, 1989.

(3) Ontario Ministry of the Environment, "The Effluent Monitoring Priority Pollutants List - 1988 Update". Hazardous Contaminants Coordination Branch, November 1988.

(4) Conover, W.J., Practical Nonparametric Statistics, 2nd. Ed.. New York, John Wiley & Sons, 1980.

(5) Ontario Ministry of the Environment, "Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment" November 1978, revised May 1984.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

VIRTUAL ELIMINATION

ISSUE

To define the long term goal of virtual elimination.

BACKGROUND

In general, the concept of virtual elimination refers to the degree to which toxic contaminants are to be eliminated from the environment.

With specific reference to the Ministry's MISA program, the issue relates to point source discharges, and to the statement of MISA's ultimate goal - the virtual elimination of persistent toxic contaminants in industrial and municipal discharges into Ontario's waterways. The Ministry's 1986 White Paper states the reason why persistent toxic contaminants should be virtually eliminated; specifically because they "*...pose a risk to fish, plants, wild life and human beings, even at low concentrations. They are persistent and either never break down or do so only very slowly. They accumulate in the environment. They are passed up the food chain in increasing amounts. This process, biomagnification, can result in thousands-fold increases in the concentration of toxic contaminants from the levels present in the ambient water to those found in large fish*".

DISCUSSION

Definitions of Virtual Elimination

A number of definitions of virtual elimination have been considered or established by various agencies. These definitions fall into one of the following three categories:

- Effects-based
- Detection Level-based
- Treatment (Technology)-based.

Effects-based Definitions

These define virtual elimination as a function of eliminating (or reducing to a defined level) the adverse effects of toxics on water quality and uses, including protection of biota and human health.

Virtual elimination could, for example, be defined as the reduction of a toxic contaminant to the point where it does not affect any water use or the health and well-being of humans or aquatic life. Under such a definition, virtual elimination could be achieved by meeting specified requirements, such as the Provincial Water Quality Objectives (PWQOs) or other criteria at the end-of-the-pipe.

Use of an effects-based definition appears to be a feasible approach. Depending on the effect level selected, it can be achieved, particularly if it involves a clearly

established and staged approach. It could be used to meet the provision in the Great Lakes Water Quality Agreement that the discharge of toxic substances in toxic amounts be prohibited. Any given set of criteria (for example, PWQO) can be used to define virtual elimination in this context.

Detection Level-based Definitions

These define virtual elimination as a function of analytical detection levels.

The ultimate expression of a detection level-based definition is the concept of zero discharge. For example, the revised Canada-U.S. Agreement states that: *"the philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge"*. Further, in Article 2(a) of the same Agreement, the following statement appears: *"...it is the policy of the Parties that:*

> *(a) the discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated"*.

Although zero discharge is not explicitly defined in the Agreement, "absence" is defined in Annex 1 as follows: *"As used in this Annex, absence means the substances are not detectable when analyzed using the best available technology..."*.

The Canada-U.S. Agreement also recognizes the practical limitations of this approach. For example, Article 7 recommends: *"In particular, research should be conducted to determine:...*

> *(c) Approaches to calculation of acceptable loading rates for persistent toxic substances, especially those which, in part, are naturally occurring."*

The adoption of a definition involving control to less than detection levels would generally represent a stringent level of control. As such, it could be perceived as an appropriate approach to control of persistent toxic substances, which the Great Lakes Water Quality Agreement singles out as requiring special attention.

Treatment-based Definitions

These define virtual elimination as a function of the required degree of removal (or allowable amount of discharge) of toxics associated with a given treatment technology.

Under this definition, virtual elimination could be defined in terms of an arbitrarily defined level of treatment. For example, BAT(EA) could be deemed to be virtual elimination, or load reduction requirements could be specified.

One concern with this type of definition is whether sector-wide BAT(EA) levels, particularly in the first round of Effluent Limits Regulations, will provide sufficient reductions in toxic contaminants to achieve virtual elimination. The experience of the U.S. EPA and other agencies suggests not. In the January 1990 Report to Congress titled, "Water Quality Improvement Study", the EPA notes that although the "floor" of BAT(EA) goes far to improve water quality, additional controls, besides BAT(EA), will be needed in some receiving waters.

Periodic Regulation Review

The development of technology-based effluent limits is the first step toward virtual elimination. It is intended that these effluent limits be based upon the "best available technology economically achievable". As such, there will be a need to review the limits periodically, in order to compare advanced technologies with those technologies upon which the limits were based. In that way, when new technologies become available which provide more stringent levels of control, the limits can be revised. It is the Ministry's intent that the review period for successive Effluent Limits Regulations, which will set new, more stringent limits based on technological advances, should be no longer than five (5) years.

However, some members of the IRC feel that the timing of the periodic review and revision of an Effluent Limits Regulation should be determined by comparing quantitative and qualitative information on the various industries. The evaluation criteria should include the environmental risk of the discharges and the potential for their reduction in any new regulations. The factors which should be considered in the evaluation include:

- Non-lethal effluents
- Water conservation
- Smallest total loading of toxic, conventional, and non-conventional substances
- Maximum use of reduction, re-use, and recycling, and smallest transfer to other media
- Number of discharging plants
- Costs and economic impacts of controls
- Extent to which treatment currently in place controls discharges.

Need for Staging

Recognizing the long term goal that all persistent toxic substances must be virtually eliminated, in the shorter term, priority consideration might be given to first accelerating the reduction of those chemical compounds that pose the greatest threat in the aquatic environment. While it was not within the strict terms of reference of the Issue Resolution Committee, a screening process was proposed for the classification of chemicals that would clearly identify priority concerns. Interim measures for achieving the accelerated reductions could take advantage of available abatement resources, identify measures to control

contaminants at source, and provide targets to advance treatment technology. The proposed screening process is detailed in the Appendix.

RECOMMENDATIONS

Based upon the information presented above and after much discussion, the Issue Resolution Committee on Virtual Elimination proposed the following recommendation for use in developing technology-based Effluent Limits Regulations:

- The MISA goal for virtual elimination of persistent toxic contaminants should be achieved stage-wise by the imposition of effluent limits. The first stage would be based on BAT(EA).

- Successive Effluent Limits Regulations would set new, more stringent limits based on technological advances.

UNRESOLVED CONCERNS *(Including Options)*

The members of the Issue Resolution Committee on Virtual Elimination could not agree upon the definition for virtual elimination; hence the various proposals discussed are presented below:

Alternative 1:

The MISA goal of virtual elimination should be the level of a contaminant below the analytical method detection limit for that contaminant. Thus, as analytical methods improve, detection limits are expected to become lower.

Alternative 2:

The MISA goal of virtual elimination should be the "acceptable level" of a contaminant at or below which there is no further "adverse effect" to the aquatic ecosystem or human health. These effects are considered in the development of Provincial Water Quality Objectives (PWQOs). Thus, the goal of virtual elimination of a contaminant should be the PWQO for that contaminant.

Alternative 3:

Certain members recommended that a new committee be formed to pursue this issue in greater detail through further dialogue with all relevant parties present. The new committee should, therefore, also include representation from environmental interest groups, the International Joint Commission, and academia.

REFERENCES

MOE. 1986. Municipal-Industrial Strategy for Abatement (MISA). A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters. (June, 1986).

International Joint Commission, 1987. Revised Great Lakes Water Quality Agreement of 1978.

MOE, 1988. Effluent Monitoring Regulations for the Petroleum Refining Sector. (July, 1988).

APPENDIX

INTERIM MEASURES FOR ACCELERATING THE REDUCTION OF TOXIC CONTAMINANTS

The long term goal of MISA is virtual elimination of all persistent toxic substances from industrial and municipal discharges into Ontario waterways. In the shorter term, priority consideration might be given to accelerating the reduction of those chemical compounds that pose the greatest threat in the aquatic environment.

Some members of the Issue Resolution Committee feel that it would be necessary to focus and prioritize the application of resources during the early stages of the MISA program, while continuing to work towards the long term goal.

Two complementary approaches to setting priorities were considered, each of which is described below.

Technology Approach

One possible focus would be to categorize the compounds on the EMPPL (or any list of contaminants of concern) and give priority to those which are of greatest environmental concern. This approach would provide a scientifically sound basis for establishing a list of persistent and bioaccumulative toxic substances, which are of serious environmental concern, and for adding to the list as additional data become available through the EMPPL listing/de-listing process.

Tables 1 through 9 attached present EMPPL compounds categorized according to a set of draft criteria for persistence and bioaccumulation. Although bioaccumulative substances were not originally specifically addressed in the MISA White Paper, it was suggested by some Issue Resolution Committee members that these be included in the prioritizing exercise; inclusion of these substances is consistent with the International Joint Commission position, set out in 1977, advocating the incorporation of bioconcentration considerations into the definition of persistence. The exercise also addresses concerns that the elemental forms of metals (with the exception of mercury) need not be as strictly controlled as the organic forms of the metals.

Water Quality Approach

Another complementary way to focus resources would be to phase in the water quality approach to pollution control. This would be done after the Effluent Limits Regulation is in place to provide the minimum pollution control requirement for each discharger.

As outlined in the MISA White Paper, the so-called "water quality track" would involve determining site-specific local effluent limits for each discharger in environmentally sensitive areas. These site-specific effluent limits would be compared to the technology based effluent limits, and the more stringent of the two would be imposed.

This approach to focusing resources would be compatible with activities already underway as part of the MISA program, such as:

- Six MISA Pilot Site Studies designed to develop site-specific effluent requirements for hazardous and conventional pollutants for designated discharges, based on receiving water impact assessments, and develop appropriate techniques for assessing impacts

- Accelerated development of Provincial Water Quality Objectives for EMPPL substances

- Developing site-specific effluent limits in 17 Areas of Concern on the Great Lakes using the techniques obtained from the Pilot Site Studies. These activities would complement and constitute part of the development and implementation of the Remedial Action Plans (RAPs)

- Other studies are also being carried out on a priority basis to impose more stringent site-specific limits to protect local sensitive receivers.

DEFINITIONS

During Committee deliberations and throughout this report, various technical terms were used. It became necessary to define these terms in order to avoid misinterpretation during discussions. Proposed definitions for the majority of terms are given below. However, not all definitions were agreed upon by the Committee; for these terms, the different definitions proposed are presented under "Unresolved Definitions".

Proposed Definitions

Bioaccumulative non-persistent toxic substance is defined as a toxic substance which is a bioaccumulative toxic substance and a non-persistent toxic substance.

Bioaccumulative toxic substance is defined as a toxic substance with a Bioconcentration Factor (BCF) greater than 1000 or an Octanol-water partition coefficient (log K_{ow}) greater than 4. These threshold values are the widely recognized definition used in the PWQO/G development process. Their use allows the identification of those substances generally recognized as very damaging to the aquatic environment.

Conventional substances include BOD_5, TSS, pH, and fecal coliforms.

Half-life is defined as the time required for the concentration of a substance to diminish to one-half of its original value in a lake or water body.

Non-conventional substances include ammonia, chlorine, colour, iron, total phenols and all other parameters monitored for in the MISA monitoring regulations including the following: chemical oxygen demand, total cyanide, ammonia plus ammonium, total kjeldahl nitrogen, nitrate plus nitrite, dissolved organic carbon, total organic carbon, specific conductance, volatile suspended solids, phenolics (4AAP method), sulphide, oil and grease, temperature, chlorine, chlorides, cyanates, dissolved solids, sulphates, thiocyanates, weak acid dissociable cyanides, iron, magnesium, fluoride and adsorbable organic halide.

Non-persistent toxic substance is defined as any toxic substance with a half-life less than eight weeks (56 days).

Persistent toxic substance is defined by the IJC as a toxic substance having a half-life in water of equal to or greater than eight weeks (56 days). For the purpose of defining Virtual Elimination, the metals which are listed in Effluent Monitoring Priority Pollutants List (EMPPL), with the exception of mercury and the organic forms of all metals, are classified as non-persistent toxic substances. With the exception of mercury, the elemental forms of metals are of comparatively less environmental concern (non-bioaccumulative).

Unresolved Definitions

Toxic Substance

Alternative 1:

Toxic substance is defined as a substance which can cause death, disease, behaviourial abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions, or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food chain or in combination with other substances. This definition is consistent with the Great Lakes Water Quality Agreement.

Alternative 2:

In addition to the above definition of "**toxic substance**" a statement should be included indicating that toxicity is a function of concentration. There is, for every substance, a concentration below which that substance is no longer toxic.

Bioaccumulative persistent toxic substance is defined as a toxic substance which is both a bioaccumulative toxic substance and a persistent toxic substance.

Alternative 1:

Priority for stringent control should be given to these substances. They are generally recognized as the substances which are most damaging to the aquatic environment.

Within the context of the MISA program, the critical substances identified by the International Joint Commission which are included on the EMPPL (PCB, hexachlorobenzene, 2,3,7,8-tetrachlorodibenzo-p-dioxin, 2,3,7,8-tetrachlorodibenzofuran, benzo-a-pyrene, and mercury) should be deemed to have met the above definition of bioaccumulative persistent toxic substances. Alkylated lead, which was also identified as a critical substance by the IJC but which is not on the EMPPL, was listed in the MISA Monitoring Regulations under the Analytical Test Group of "Total alkyl lead". This group will be screened for addition to the EMPPL. The International Joint Commission (IJC) critical substances which are not EMPPL substances (DDT and its metabolites, dieldrin, toxaphene and mirex) are regulated through other programs in Ontario.

Alternative 2:

The critical substances identified by the International Joint Commission which are included on EMPPL should not be automatically included in the bioaccumulative persistent toxic substances category unless they pass the criteria used to define bioaccumulative persistent toxic substances. These latter criteria should be published in draft form for peer review prior to adoption.

End of Pipe

Alternative 1:

End of pipe should be defined as a location in an effluent stream situated before the place of discharge to the surface watercourse, after any available treatment technology, and upstream of any significant contaminant masking or significant dilution with any other type of effluent.

Alternative 2:

End of pipe should be defined as a location representative of the final effluent and immediately prior to the place of discharge to the surface watercourse. Protection of Ontario's waterways will be attained if the long-term MISA goal of meeting Provincial Water Quality Objectives and Guidelines at the point of entry into the surface watercourse is achieved.

Table 1. EMPPL Substances - Persistent, Bioaccumulative

1,2,3,4-Tetrachlorobenzene
1,2,3,5-Tetrachlorobenzene
1,2,4,5-Tetrachlorobenzene
2,3,7,8-T4CDD
2,4,5-Trichlorotoluene
2-chloronapthalene
4-Bromophenyl phenyl ether
4-chlorophenylphenyl ether
Anthracene
Antimony
Aroclor 1016*
Aroclor 1242*
Aroclor 1248*
Aroclor 1254*
Aroclor 1260*
BENZ(A)ACRIDINE
Benz(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
BENZO(J)FLUORANTHENE
Benzo(k)fluoranthene
Camphene
Chlorinated dibenzo-p-dioxins (+5,6,7, & 8)
Chlorinated dibenzofurans, tetra (+5,6,7, & 8)
Chrysene
Dibenz(a,h)anthracene
DIBENZOFURAN
DIPHENYL 4,4'-METHYLENEDICARBANILATE
Diphenyl ether
Fluoranthene
Hexachlorobenzene
Indeno(1,2,3-cd)pyrene
Limonene
Mercury
Nickel
Pentachlorobenzene
Pentachlorophenol
Perylene
Phenanthrene
Pyrene

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 2. EMPPL Substances - Persistent, Not Bioaccumulative

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICLOROETHANE
1,1,2,2-Tetrachloroethane
1,1-Dichloroethane
1,2-Dichloroethane
2-MERCAPTOBENZOTHIAZOLE DISULPHIDE
Acridine
Aroclor 1221*
Aroclor 1232*
Arsenic
Benzeneacetonitrile
BENZO(H)QUINOLINE
bis(2-chloroethoxy)methane
bis(2-chloroethyl) ether
bis(2-chloroisopropyl) ether
bis(Chloromethyl)ether
BORNEOL
BORON
BROMODICHLOROMETHANE
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloromethane
CINEOLE
Cobalt
Diphenylamine
Hexachloroethane
Indole
Molybdenum
MORPHOLINE
N-DODECANE
P-BROMOPHENOL
THIOPHENE
trans-1,2-Dichloroethylene
Trichlorofluoromethane
Zinc

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 3. EMPPL Substances - Persistent, Unknown Bioaccumulation

1,1-DICHLORO-1,2,2,2-TETRAFLUOROETHANE
1,2,3,4,5,6-HEXACHLOROCYCLOHEXANE (GAMMA ISOMER) (LINDANE)
2,4-Dinitrophenol
2-CHLORO-1,1,1,4,4,4-HEXAFLUORO-2-BUTENE
Aluminum
Beryllium
Cadmium
Chromium
Copper
Lead
LITHIUM
N-CYCLOHEXYL-2-BENZOTHIAZOLESULPHENAMIDE
PINE OIL (MIXTURE)
Selenium
Silver
STRONTIUM
Tetraethyl lead
Thallium
Triethyl lead
URANIUM
Vanadium

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 4. EMPPL Substances - Unknown Persistence, Bioaccumulative

1-chloronapthalene
Octachlorostyrene

Table 5. EMPPL Substances - Unknown Persistence, Not Bioaccumulative

2,6-Dinitrotoluene
3,3'-Dichlorobenzidine
5,6-DIHYDRO-2-METHYL-1,4-OXATHIIN-3-CARBOXANILIDE
5,6-DIHYDRO-2-METHYL-1,4-OXATHIIN-3-CARBOXANILIDE-4,4-DIOXIDE
Acrolein
Benzidine
Bromomethane
Chloroform
Hexachlorobutadiene
m-xylene
Mercaptobenzothiazole
Napthalene
o-Xylene
p-Xylene
Styrene

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 6. EMPPL SUBSTANCES - Unknown Persistence, Unknown Bioaccumulation

1,2-Dichloropropane
1,4-Dioxane
4-Aminoazobenzene
Acrylonitrile
Aniline
Bromoform
Ethylene dibromide
Ethylene thiourea
Formaldehyde
Hydrazine
Methylene Chloride
Thiourea

Table 7. EMPPL Substances - Not Persistent, Bioaccumulative

(Z)-9-OCTADECEN-1-OL
1,2-DIETHYLBENZENE (ORTHO)
1,3-DIETHYLBENZENE (META)
1-METHYLPHENANTHRENE
1-OCTADECANOL
2,3,4,5-Tetrachlorophenol
2,3,5,6-Tetrachlorophenol
2,6,-Di-t-butyl-4-methylphenol
2-Methylnaphthalene
2-METHYLPHENANTHRENE
4,4'-DI-N-OCTYLDIPHENYLAMINE
5-nitro Acenaphthene
Abietic acid**
Biphenyl
bis(2-ethylhexyl)phthalate
Di-n-butylphthalate
DIMETHYLNAPHTHALENE (ISOMER NONSPECIFIC)
N-OCTADECANE
Oleic acid
Tetrachloroguaiacol
Tributyl phosphate
Trichloroguaiacol
Trimethyl naphthalene
TRIXYLYL PHOSPHATE

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 8. EMPPL Substances - Not Persistent, Unknown Bioaccumulation

1,1,2-Trichloroethane
1,1,3,3-Tetrachloroacetone
1,1,3-Trichloroacetone
1,1-Dichloroethlyene
1,2,3,4-TETRAHYDRONAPTHALENE (TETRALIN)
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4,6-Trichlorophenol
2,4-Dichlorophenol
4,6-Dinitro-o-cresol
Abietic acid**
BENZO(B)THIOPHENE
Butyl benzyl phthalate
Chlorodehydroabietic acid
CYCLOHEXYLAMINE
DI-N-OCTYL PHTHALATE
Fluorene
Isopimaric acid
Levopimaric acid
N-MORPHOLINYL-2-BENZOTHIAZOLESULPHENAMIDE
N-T-BUTYL-2-BENZOTHIAZOLESULPHENAMIDE
Neoabietic acid
Pimaric acid
POTASSIUM ETHYL XANTHATE
POTASSIUM HEXYL XANTHATE
SODIUM BUTYL XANTHATE
SODIUM DIMETHYLDITHIOCARBAMATE
SODIUM ETHYL XANTHATE
TANNIC ACID (MIXTURE)
Tetrachloroacetone
Toluene
ZINC DIETHYLDITHIOCARBAMATE

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

Table 9. EMPPL Substances - Not Persistent, Not Bioaccumulative

1,2,3-Trichlorobenzene
1,2,4-TRIMETHYLBENZENE
1,2-DICHLOROBUT-3-ENE
1,2-DIPHENYLHYDRAZINE
1,3-Butadiene
1,3-ISOBENZOFURANDIONE (PHTHALIC ACID ANHYDRIDE)
1,4-DICHLOROBUT-2-ENE
1-BROMO-2-CHLOROMETHANE
1-METHYL-2-PYRROLIDINONE
1-Methylnaphthalene
1-NAPHTHALENOL
1-Nitronaphthalene
1H-BENZIMIDAZOLE
2,3,4,6-Tetrachlorophenol
2,3,4-Trichlorophenol
2,3,5-Trichlorophenol
2,4,5-Trichlorophenol
2,4-Dimethylphenol
2,4-Dinitrotoluene
2,4-TOLUENE DIISOCYANATE
2,5-DIMETHYLPHENOL
2,6-Dichlorophenol
2,6-DIMETHYLPHENOL
2,6-TOLUENE DIISOCYANATE (2,6-TDI)
2-(2-BUTOXYETHOXY)ETHANOL
2-BUTENOIC ACID
2-BUTOXYETHANOL
2-FURANMETHANOL (FURFURYL ALCOHOL)
2-HYDROXY-3-METHYL-2-CYCLOPENTEN-1-ONE
2-hydroxybiphenyl
2-MERCAPTOETHANOL
2-METHYLPYRIDINE
2-Nitronaphthalene
2-NITROPHENOL
3,4-DIMETHYLPHENOL
3,5-DIMETHYLPHENOL
4,5-DICHLOROGUAIACOL
4-chloro-3-methylphenol
4-hydroxybiphenyl
4-Nitrophenol
4-NITROSOMORPHOLINE
8-QUINOLINOL
9H-CARBAZOLE
Acenaphthene

Table 9. Cont'd.

ACETONE
ACRYLAMIDE
ALPHA-METHYLFURAN
Benzaldehyde
Benzene
Benzyl alcohol
Butanal
CAFFEINE
CARBON DISULFIDE
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropylene
CYCLOHEXANOL
CYCLOHEXANONE
Dehydroabietic acid
DICHLOROBUTENE (ISOMER NONSPECIFIC)
DIETHYL PHTHALATE (DEP)
Dimethyl disulphide
DIMETHYL PHTHALATE
DIMETHYL SULPHIDE
DIMETHYLPHENOL (ISOMER NONSPECIFIC)
DIPHENYLMETHANE 4,4'-DIISOCYANATE (MDI)
ETHANOL
ETHYLBENZENE
Eugenol
FURFURAL
GUAIACOL
Hexachlorocyclopentadiene
HYDROGEN SULPHIDE
ISOPHORONE
m-Cresol
M-METHYLSTYRENE
Methyl ethyl ketone
METHYL METHACRYLATE
Methyl styrene
N,N-DIETHYL-M-TOLUAMIDE (DEET)
N-(2-HYDROXYPHENYL)ACETAMIDE
N-BUTYLAMINE
N-HEXANE
n-Methyl formamide
n-Nitrosodi-n-propylamine
n-Nitrosodimethylamine
n-Nitrosodiphenylamine
N-PENTANE
N-PHENYLACETAMIDE

Table 9. Cont'd.

NITROBENZENE
o-chlorophenol
o-Cresol
p-Cresol
P-METHYLSTYRENE
PENTACHLOROETHANE
Phenol
PYRIDINE
QUINOLINE
Tetrachloroethylene
TETRAETHYLTHIURAM DISULPHIDE
TETRAHYDROFURAN
TETRAMETHYLTHIURAM DISULPHIDE
TOLUENE DIISOCYANATE-MIXTURE (TDI)
trans-1,3-Dichloropropylene
Trichloroethylene
TRICHLORONITROMETHANE
Trimethylbenzenes
VANILLIC ACID
Vinyl chloride

NOTE: Use of upper case denotes those substances added to the EMPPL after 1987.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

BEST AVAILABLE TECHNOLOGY

ISSUE

To develop a process for Best Available Technology (BAT) selection through the application of standard procedures and criteria across all industrial and municipal sectors. A combination of treatment technologies, production process changes, best management practices, and in-plant controls could serve as a technology for a particular treatment level, such as BAT. This technology is used only as a model to set the effluent limits and no plant is obliged to use it in order to meet the limits. A particular plant could achieve the applicable effluent limits through any combination of technology approaches.

BACKGROUND

The Joint Technical Committee (JTC) will recommend Effluent Limits Regulation requirements for each industrial and municipal sector. Ontario, Canadian, and other data sources and experience with technology will be used where available. The U.S. EPA approach, and the supporting information developed in the process of defining regulations under the U.S. Clean Water Act, will be considered where appropriate.

U.S. EPA Program

Definitions

Effluent limitations were developed by the U.S. EPA for industrial sectors and sub-sectors to regulate the discharge of conventional, non-conventional and toxic substances from new and existing sources to a receiving watercourse. Pretreatment standards were also developed to regulate the discharge of these substances from new and existing sources to municipal sewage treatment plants.

Effluent limitations based on the application of Best Practicable Control Technology Currently Available (BPT), and where applicable Best Conventional Pollutant Control Technology (BCT), were used to control conventional parameters (BOD_5, TSS and pH).

For existing sources discharging directly to a receiving watercourse, effluent limitations were developed to control the discharge of toxic contaminants and non-conventional pollutants based on the application of Best Available Technology Economically Achievable (BATEA).

For new sources discharging directly to a receiving watercourse, New Source Performance Standards (NSPS) were developed to control the discharge of toxic contaminants and non-conventional pollutants based on the application of Best Available Demonstrated Technology.

For existing sources discharging to a municipal sewage treatment plant, Pretreatment Standards for Existing Sources (PSES) were developed to control the discharge of toxic contaminants and non-conventional pollutants.

For new sources discharging to a municipal sewage treatment plant, Pretreatment Standards for New Sources (PSNS) were developed to control the discharge of toxic contaminants and non-conventional pollutants.

Inventory of Available Technologies

The U.S. EPA mainly used U.S. sources of information and established an inventory of available technologies for each sector and sub-sector using the following:

- Questionnaires issued under Section 308 of the CWA, which provided information on the industry profile and performance data
- EPA waste characterization surveys of targeted plants. (These included short and long term studies. The short term studies lasted up to three days long and the longer studies were 15-20 days in duration. In some cases the short term studies covered three days of sampling in two locations only. The long term studies were usually carried out by the consultants or by the industries themselves)
- Reviews of the technical literature, technical journals, and proceedings from environmental conferences
- Specialized bench- and pilot-scale studies of promising technologies.
- Other available U.S. EPA data bases (sampling studies done by the EPA in the past)

In the case of the Pulp and Paper category, in addition to the information collected from the literature, data was obtained from Sweden as well as from Canada. This data base is being updated every six (6) months.

The quantity of data varied. It appears that there were no fixed rules for data gathering. The amount of data collected was governed by the size of the budget or the proximity of deadlines.

As for the quality of data, EPA considered only data with available QA/QC.

Technology Assessment

Based on the information gathered, the U.S. EPA identified available treatment processes that were generally demonstrated at full-scale within the sector. However in developing the effluent limitations, they were not obliged to use only technology that had been demonstrated in the sector. They also used "technology transfer", that is, technologies proven effective in another sector.

For example, in the Organic Chemicals, Plastics and Synthetic Fibres (OCPSF) sector, technology from the Metal Finishing sector was used as BAT for plants

whose concentrations of metals fell within the range of concentrations found in process effluents from metal finishing plants. This approach was chosen as there was no metals treatment performance data available for the OCPSF sector for the specific products or processes.

Basically, EPA's effluent limitations guidelines development procedure used the concept of a model technology. EPA selected a combination of treatment technologies and in-plant controls to serve as its model technology for a particular treatment level, such as BAT. It should be noted that this model technology was used only to set the limits and no plant was obliged to follow it in order to meet the limits. A particular discharger could achieve the applicable effluent limitations guidelines through any combination of technology approaches.

Sub-Sectoring

The U.S. EPA applied the following general approach to sub-sectoring for each sector:

- Identification of the factors which could be used to sub-categorize the sector
- Determination of the correlation between each factor identified and the effluent quality with respect to both conventional and toxic substances using "engineering technical analyses" and in some cases, a statistical approach
- Determination of the factors which affect effluent quality and which are inter-related
- Selection of the dominant factor as a means of sub-sectoring.

The factors evaluated differed between sectors and were based on knowledge of the sector.

BAT Selection

In developing effluent limitations for new sources in the Organic Chemicals, Plastics and Synthetic Fibers sector, the NSPS limitations were established for conventional substance on the basis of BPT and for toxic substances on the basis of BAT. A distinction between existing and new sources was not made as the sub-sectoring approach fit both source types. PSNS and PSES limitations were identical and did not differentiate between new and existing sources for the same reason.

A different approach was taken in the Iron and Steel Manufacturing sector. The NSPS limitations are based upon the same basic technologies used to develop the BPT and BAT limitations. In some sub-sectors, however, the NSPS limitations are more stringent that the BPT and BAT limitations as new plants may be designed with water conservation in mind.

The Best Available Technology Development Process in Ontario

The activities in which each Joint Technical Committee (JTC) will likely be involved as part of the development of the Best Available Technology (BAT) options for a sector or sub-sector are outlined below:

- Develop new sectors and/or sub-sectors, if required
- Review the identified contaminants of concern as developed from the Effluent Monitoring Regulation, and/or other sources, for the sector or sub-sector
- Identify the stream types for which BAT options may be developed
- Identify and/or develop BAT options from the available technologies which can be used to treat, recycle, reduce, reuse, or eliminate the pollutants of concern in all the effluent types (process effluent, combined effluent, stormwater and once through cooling water) for the sector or sub-sector, based upon a set of pre-determined objectives
- Weigh the objectives and rank each BAT option
- Determine the pollutants which can be controlled, and hence limited, by each BAT option, as well as the levels to which pollutants are reduced
- Estimate the cost to install the BAT options at each plant in the sector or sub-sector not currently utilizing the BAT options.

Using the above-listed schedule of activities as a guide, along with U.S. EPA experience, as appropriate, the Issue Resolution Committee proposed recommendations for determining Best Available Technology. These recommendations are presented in the following section.

RECOMMENDATIONS

The following recommendations are proposed by the Issue Resolution Committee on Best Available Technology:

Sector/Sub-Sector Development

- Due to the variety of manufacturing processes, raw materials, treatment technologies, and the like used by plants within a sector, there may be a need to sub-divide an existing sector into sub-sectors. The procedures, criteria and factors for sub-dividing a sector must be chosen carefully to limit the existence of sub-sectors consisting of one plant only. In establishing similarity of process effluents, Best Professional Judgement (BPJ) should be used since effluents are never identical, even if they come from similar plants.

- Sub-sectoring should be considered when process effluent characteristics differ significantly. In cases where only final effluent data are available, Best Professional Judgement (BPJ) should be used to determine whether or not the process effluent was significantly different with respect to both the untreated and the treated wastewater characteristics.

- As a general rule, differences in process effluent quality resulting from different management practices or from minor process variations or interchangeable process chemicals would not be considered justification for sub-sectoring.

- Sub-sectoring should only be applied where it will lead to more stringent effluent limits.

- A sub-sector should not be smaller than two Ontario plants.

- Not all the factors considered for sub-sectoring would apply to all sectors.

- The major factors that may be considered when developing sub-sectors include differences in the following:
    - Raw materials
    - Production processes
    - Products manufactured
    - Use of process chemicals
    - Effluent treatment technology
    - Source of process effluent.

  Other factors, such as those listed below, may also be considered under special circumstances:
    - Geographic location
    - Age of plant
    - Size of plant
    - Energy and non-water quality impacts
    - Water usage.

Contaminants of Concern

- The JTC should consider the contaminants of concern identified from the data collected under the sectoral Effluent Monitoring Regulation, and any other sources as necessary, when examining available technologies for consideration as a BAT option.

Stream Types

- The stream types and streams at each plant in the sector or sub-sector for which limits are desired should be identified.

- BAT options should be developed for process effluents, combined effluent streams, once through cooling waters, and stormwater of the plants in the sector or sub-sector.

Available Technologies

- An available technology, which may be considered as a BAT option, may be:
    - Changes in production processes
    - In-plant controls
    - Effluent treatment technologies
    - Best management practices

  or a combination thereof found anywhere in Ontario, Canada, the United States, and/or the developed industrial countries of the world in the sector or sub-sector, or a similar sector or sub-sector that produces process effluents with similar characteristics.

  Changes in production processes are considered to be changes to those technologies applied at a plant in all steps of the production of its intermediate and final products. Changes in production processes could be as simple as the substitution of chemicals in order to eliminate use or formation of toxic pollutants.

  In-plant control is a technique used to improve effluent quality and reduce or eliminate formation of pollutants and the need for external effluent treatment. Examples of in-plant controls include: pre-treatment of a segregated (concentrated) process effluent stream; prevention of toxic chemicals from getting into effluent streams; and, reduction, re-use, and recycling of process effluent streams.

  Effluent treatment processes are considered to be those technologies which are used to eliminate or reduce the total loading of conventional and toxic contaminant substances from effluent streams.

Best management practices are those specific facilities or procedures used to:

- Manage site runoff and drainage from outdoor process and non-process areas resulting from stormwater or thaw events
- Control once through cooling water
- Minimize by-passes of the effluent treatment system
- Manage sludge and waste disposal
- Minimize the impact of spills.

To be considered an available technology, the best management practice should provide specific effluent performance results.

Demonstrated Technology

- A technology can be considered a demonstrated technology if data on the technology is available and that data can be used to predict, with a reasonable degree of confidence, the reliability of the technology and the performance of the technology with respect to contaminant reductions and effluent variability at any plant in the sector or sub-sector, given the expected variability between plants, and could be successfully retrofitted into existing facilities with a reasonable degree of confidence. Demonstrated technologies may be selected from the list of available technologies by the JTC by utilizing the criteria given below.

- The criteria that an available technology should satisfy to be considered as a demonstrated technology are as follows:
  - Utilized in the sector or sub-sector
  - Utilized in a similar sector or sub-sector that produces effluents with similar characteristics
  - Can be retrofitted into existing facilities
  - Should preferably be in commercial use for a sufficient time (generally one year)
  - Design/sizing and costing information should be available or sufficient information should be available to develop design/sizing and costing criteria
  - Bench- or pilot-scale technology can be considered if justification can be provided.

- The process for selecting BAT options from the list of demonstrated technologies would consider primarily their ability to remove contaminants, and secondarily the following goals for an effluent, as determined at the BAT option effluent sampling point:
  - Non-lethal to trout and Daphnia
  - Maximum use of reduction, re-use and recycling, and smallest transfer to other media
  - Maximum water conservation.

- The JTC should consider the goals and objectives as listed above when developing BAT options from the demonstrated and combined technologies. To do this the JTC should consider the demonstrated or combined technologies that satisfy all of the objectives to the greatest extent possible. This may mean that the JTC will have to rank and provide relative weights for each of the objectives in order to develop a BAT option.

- While it is recognized that virtual elimination may not be economically achievable for all sectors, particularly in the first round of Effluent Limits Regulations, the selection of BAT options should demonstrate that progress toward the goal of virtual elimination is being made

Factors to be Considered in BAT Selection

- The impact resulting from the release of a given contaminant substance to the natural environment will differ for each contaminant substance. Evaluating technologies solely on their ability to reduce the total mass loading of toxic contaminant substances may be misleading. To overcome this problem, Toxic Weighting Factors (TWF) should be used. One approach could be the adoption of the U.S. EPA copper standard. In this case two water quality criteria are used to make up the toxic weighting factor: human health ingestion criteria and aquatic chronic criteria.

- The selection of BAT should promote water conservation. No backsliding on water use per unit of production would be allowed and the selection of BAT should demonstrate that progress is being made towards increased implementation of reduction, re-use, and recycling.

- The application of BAT should not result in the unabated transfer of substances to air or land, and should demonstrate that progress is being made towards the goal of virtual elimination.

- Data gathered from the various sources may not all be of the same quality as that required by the MISA Effluent Monitoring Regulation or Effluent Limits Regulations. To ensure that the effluent limits are based on acceptable data, procedures and criteria are required to ensure that the data is of appropriate quality. The following procedures and criteria are suggested:
    - For each available technology, and where applicable, the available technology influent and effluent sampling points should be established
    - The performance of the technology should be determined using these sample points
    - Raw data should be collected wherever possible
    - When data from a literature source is provided, a reference to the original data source must be provided

- The raw data, raw data source, and agency collecting the data should be reviewed before it can be considered available technology data
- Usually, only publicly available data should be considered available technology data.

- For each contaminant for which an effluent limit is proposed, it should be demonstrated that the BAT option controls that contaminant.

BAT Selection

- A short list of at least four (4) BAT options should be developed for the purposes of Economic Achievability analysis. It is anticipated that the BAT options will be the demonstrated and combined technologies which best advance the sector or sub-sector towards the realization of the goal and objectives of the MISA program. It is suggested that the following BAT options should be selected, among others:
  - A BAT option that utilizes the best technologies currently in use in North America, Europe, or Japan
  - The BAT option selected by the US EPA for the sector or sub-sector in question
  - A BAT option that utilizes the best technologies currently in use in Ontario in the sector or sub-sector in question; and
  - A BAT option consisting of any technologies or combinations of technologies which advance the sector or sub-sector towards the goals, policies and objectives stated above.

Subsequent Activities

- The selection process would provide a list of BAT options; these BAT options will move forward for further analysis. The further analysis would include:
  - Setting effluent limits for those substances controlled by each BAT option
  - A technical cost evaluation of each BAT option
  - An economic achievability evaluation of each BAT option.

UNRESOLVED CONCERNS

None.

DEFINITIONS

During Committee deliberations and throughout this report, various technical terms were used. It became necessary to define these terms in order to avoid misinterpretation during discussions. Proposed definitions for the terms are given below.

BAT is the abbreviation for Best Available Technology and is a combination of demonstrated treatment technologies and in-plant controls. This technology is used only to set the effluent limits and no plant is obliged to use it in order to meet the limits. A particular plant could achieve the applicable effluent limits through any combination of technology approaches

BAT(EA) is the abbreviation for Best Available Technology Economically Achievable

BAT option the use of demonstrated or combined technologies, from one or more plants to derive limits for a process effluent, once through cooling water, stormwater or combined effluent

BAT option effluent sampling point means a location in an effluent stream situated after a BAT option, before the place of discharge to the surface watercourse and upstream of any significant contaminant substance masking or significant dilution with any other effluent

best management practices are those facilities or procedures used to: (1) manage site runoff and drainage from outdoor process and non-process areas resulting from stormwater or thaw events; (2) minimize by-passes from the effluent treatment system; (3) manage sludge and waste disposal from effluent treatment systems; (4) manage once through cooling water; and (5) minimize the impact of spills; which are associated with, or ancillary to, the plant and effluent treatment systems and which may contribute contaminant substances to the receiving waters

BPT is the abbreviation for best practical technology and is based on the average of the best existing performance by plants of various sizes, ages, and unit processes. It focuses on end-of-pipe treatment rather than process changes or internal controls

by-pass means the diversion of untreated or partially treated process and combined streams, once through cooling water, stormwater, surface runoff, infiltration or waste streams from any part of a plant or effluent treatment facility or collection system that results in the discharge of an effluent to the receiving waters

combined effluent means an effluent resulting from the intentional combination of process effluent and cooling water; process effluent and stormwater; process effluent, cooling water and stormwater; cooling water and stormwater

combined technologies the use of demonstrated technologies from more than one plant to create a demonstrated technology for a type of effluent stream

conventional substances include BOD_5, TSS, pH, and fecal coliforms

cooling water means water and associated material that is used in an industrial process for the purpose of removing heat and that is not intended to come into contact with process materials

demonstrated technology means a technology for which data are available and that data can be used to predict, with a reasonable degree of confidence, the reliability of the technology and the performance of the technology with respect to contaminant reductions and effluent variability at any plant in the sector or sub-sector, given the expected variability between plants, and could be successfully retrofitted into existing facilities with a reasonable degree of confidence.

demonstrated technology effluent sampling point means a location in an effluent stream situated before the place of discharge to the surface watercourse, after the demonstrated technology used to treat the effluent, and upstream of any significant contaminant substance masking or significant dilution with any other effluent

demonstrated technology influent sampling point means a location in an effluent stream situated before the demonstrated technology

effluent means any liquid and associated material discharged, directly or indirectly, to a surface watercourse

effluent treatment processes are considered to be those effluent treatment technologies which are used to eliminate or reduce the total loading of conventional, non-conventional and toxic contaminant substances from effluent streams

in-plant control is a technique used to improve effluent quality and reduce or eliminate the formation of pollutants and, thus, the need for external effluent treatment (e.g. in-plant control may include pre-treatment of a segregated (concentrated) waste stream at a plant unit; good design to prevent toxic chemicals from getting into the process effluent; and recycle, reuse and reduction of process effluent)

plant means an industrial or municipal facility and the developed property and waste disposal sites associated with it

process effluent means effluent that by design comes into contact with any chemicals in an industrial process

production processes are the basic fundamental technologies employed at a plant to manufacture the specific range of intermediates and final products from the various raw materials

similar sector or sub-sector is a sector or sub-sector that produces process effluents, once-through cooling water or stormwater with similar contaminant substances and contaminant substance concentrations

stormwater means run-off from a storm event or thaw that is discharged from a developed or undeveloped area of a plant directly or indirectly to a surface watercourse

thaw in relation to a plant means the melting of snow or ice sufficient to create an effluent stream at the plant

toxic substance is defined as a substance which can cause death, disease, behaviourial abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions, or physical deformities in any organism or its offspring, or which can become poisonous after concentration in the food chain or in combination with other substances. For the purposes of the MISA program the EMPPL list comprises the list of toxic substances.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

ECONOMIC ACHIEVABILITY

EXECUTIVE SUMMARY

PRIVATE SECTOR AND CROWN CORPORATION
ECONOMIC ACHIEVABILITY ASSESSMENT

Purpose of This Document

- To provide the Joint Technical Committees (JTCs) with the principles, procedures and criteria to use as a framework for carrying out economic achievability assessments of Best Available Technology (BAT) options.

Objective of Economic Achievability Assessments

- To ensure that the JTCs understand the economic and financial consequences of effluent reduction (BAT) options in order to recommend a Best Available Technology, Economically Achievable (BATEA).

Recommendations of the Issue Resolution Committee

I. Cost-effectiveness analysis can be used to define a subset of BAT options that will achieve various alternative abatement levels at least-cost.

II. Economic achievability (EA) analyses do not provide decision rules for choosing a BAT option or setting limits. The results of EA assessments will provide inputs to JTC deliberations.

III. Cost estimation:

A. To be undertaken by JTC working groups.

B. Collection of plant-level data, including estimates of private benefits from pollution control.

C. At least 4 BAT options should be estimated in order to generate a range of costs for EA assessments.

D. Previous environmental protection costs would be considered to the extent possible, but not added explicitly to relevant MISA costs.

E. Costs of present environmental regulatory initiatives and mandated requirements other than proposed MISA regulations should be considered in assessments to the extent possible, recognizing limitations in capital availability.

F. Non-environmental regulatory costs should not be included in the analysis, but should be noted to the extent possible.

IV. Determination of cost-effectiveness:

A. Identification of least-cost BAT options.

V. Analysis of economic and financial consequences (economic achievability assessment):

A. Would be carried out for one or more of the identified BAT options.

B. Should be based on assessments of the effects of estimated costs of abatement on selected financial performance indicators.

C. In the absence of more disaggregated data, publicly available firm- or sector-level data should be used. Plant-level analyses would be carried out as appropriate and if data are made available. The onus to bring this information forward is on the affected firms.

D. Would consider the distribution of effects from a variety of perspectives, including: competitiveness, profitability, employment, and price impacts.

Unresolved Concerns

Alternative 1: Public benefits, in the context of formal cost-benefit analyses, should not form part of the basis for JTC decisions during development of Effluent Limits Regulations for each sector.

Alternative 2: The JTCs should consider public benefits when developing the Limits Regulations.

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1.0 PURPOSE AND INTENT

The purpose of this document is to provide the sectoral Joint Technical Committees (JTC) with the principles, procedures and criteria to use as a framework for carrying out assessments of economic achievability for private sector entities and crown corporations subject to the MISA abatement requirements. Unless otherwise specified, it is assumed that assessments will be carried out as part of JTC deliberations, which will be able to take into account sector specific factors.

This document states the position of the MISA Issues Resolution Committee on Economic Achievability. Where there remains a difference in position between the various Issue Resolution Committee members, alternative position statements are provided. In addition, a glossary defining technical and economic terms is provided.

1.1 Overview

The MISA White Paper[1] states that effluent limits regulations will be determined on a basis of **Best Available Technology,** ***Economically Achievable*** (BATEA). The purpose of the present "position" paper is to set out guidelines for the economic and financial analyses of economic achievability. Analytical procedures, conventions, data requirements, and tests and criteria will be specified which can be applied to evaluate the financial and economic consequences associated with "Best Available Technology" (BAT) options for private firms and crown corporations.

The potential BAT options for each sector are to be defined by its Joint Technical Committee (JTC) in accordance with guidelines set forth by the MISA Issue Resolution Committee on BAT.

The analytic components, and the role of economic achievability assessments in the MISA context, are illustrated in Figures 1-1 and 1-2. Capital and operating and maintenance (O&M) costs of potential BAT options, in conjunction with financial and economic analyses will provide the sectoral JTCs with the range of financial and economic consequences associated with each potential BAT option.

With these facts in hand, a clearer view of the economic and financial consequences of different BAT options can be presented. Such information is an important input to the JTC process of providing a sound recommendation for the option proposed as Best Available Technology, Economically Achievable.

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[1] Ontario Ministry of the Environment. *Municipal-Industrial Strategy for Abatement (MISA): A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters.* 1986.

1.2 Organization of This Document

Economic and financial analyses have been employed in Ontario for the development and implementation of environmental policies and programs for many years. Other jurisdictions in Canada, the United States and elsewhere have also made economic and financial considerations an explicit part of the regulatory process to varying degrees. The key analytical tools that have been applied include cost/benefit analysis; economic and financial impact analyses; and cost effectiveness assessments. Chapter 2 will provide a short review of the current uses of economic and financial analyses for environmental policy in Ontario and elsewhere.

Chapter 3 addresses the economic principles and rationale for assessing the economic and financial consequences of environmental protection activities. It is also shown that economic principles provide a consistent framework for displaying the consequences of alternative courses of action.

It is sometimes possible to determine ranges of environmental protection activity that are clearly desirable and other ranges in which there may be substantial agreement. However, clear-cut outcomes are unusual because the costs of such programs are generally borne by parties other than the major beneficiaries.

A prospective economic and financial assessment of proposed MISA Limits Regulations involves two broad stages. The costs of implementing different levels of abatement, net of any private benefits that may arise from the changes, will be estimated for individual plants and then aggregated to allow financial and economic analyses to be carried out. Potential financial and economic consequences of the estimated costs must be determined.

Chapter 4 lays out procedures for the determination of net (of private benefits) costs of each BAT option. The concept of the abatement cost function is presented, and procedures are described for deriving these tools. Cost-effectiveness analyses are defined, and information requirements to apply the analytical procedures are identified. A ***Cost-effective BAT option*** **is defined as a combination of one or more technologies and best management practices that jointly achieve a specified level of pollution removal at least cost.** To derive an abatement cost function that is sufficient for the analysis of economic achievability, it is necessary to consider a number of cost-effective BAT options.

Chapter 5 focuses on the economic and financial consequences of the costs associated with the various BAT options. Analytical procedures are defined, along with the rationale for their use. Criteria for setting threshold ranges with which to evaluate economic and financial consequences are proposed. The implications of market structure for assessment of the effects of BAT option costs are discussed. This section also notes a number of conventions and assumptions that will apply to the financial and economic analyses.

The discussion of the earlier chapters is summarized in Chapter 6. Recommendations and concluding remarks are provided as well.

ANALYTIC COMPONENTS OF ECONOMIC ACHIEVABILITY

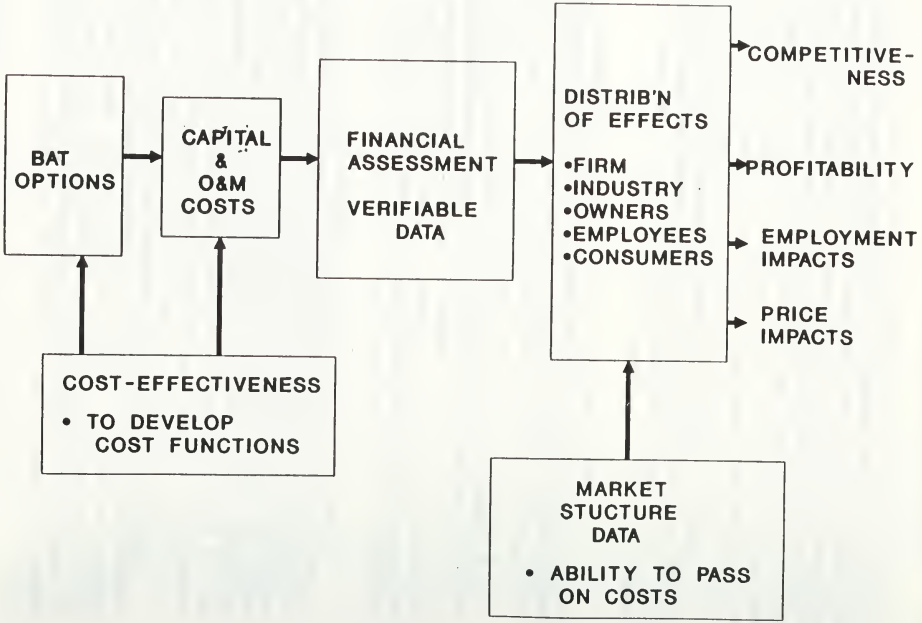
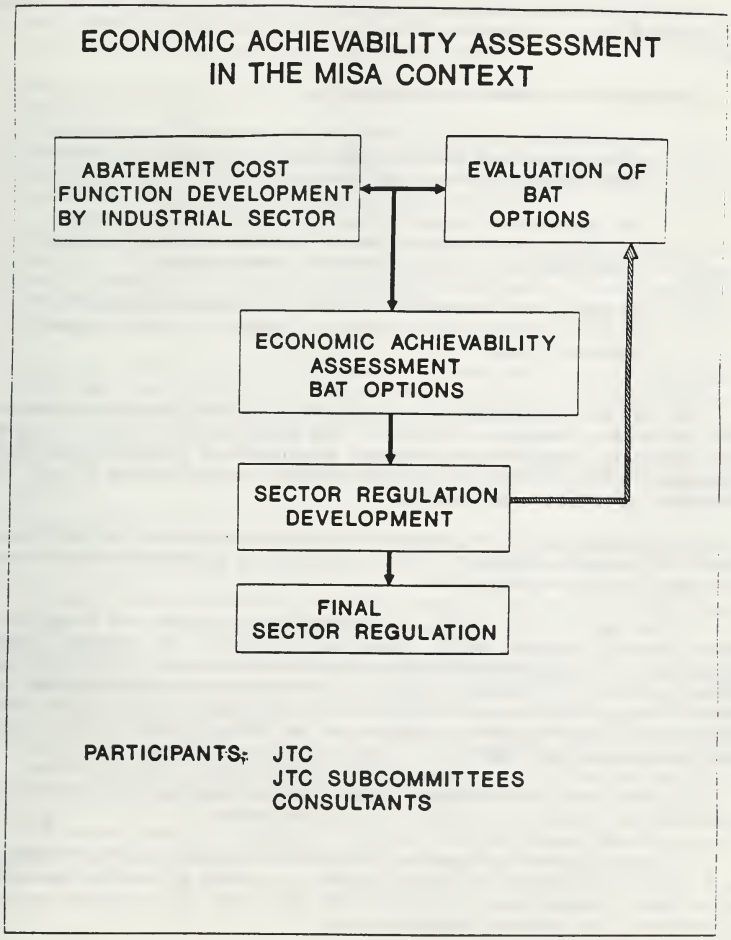


FIGURE 1-1

FIGURE 1-2


ECONOMIC ACHIEVABILITY ASSESSMENT
IN THE MISA CONTEXT
ABATEMENT COST FUNCTION DEVELOPMENT BY INDUSTRIAL SECTOR
EVALUATION OF BAT OPTIONS
ECONOMIC ACHIEVABILITY ASSESSMENT BAT OPTIONS
SECTOR REGULATION DEVELOPMENT
FINAL SECTOR REGULATION
PARTICIPANTS: JTC
JTC SUBCOMMITTEES
CONSULTANTS

1.3 Summary of Issues and Assumptions

It is the position of some Issue Resolution Committee members that cost-benefit analyses should not be prepared as the basis for development of the Effluent Limits Regulations.

Other Committee members, however, state that:

> "Environmental protection is necessary for the sustainable development of the economy of Ontario. The cost of environmental protection would be borne by all segments of society.
>
> The environmental impact of each increasing level of protection technology added to industrial facilities need to be assessed to ensure society benefits from the utilization of its scarce resources.
>
> A public benefits assessment should be prepared with the full participation of the affected parties to identify the specific benefits society will realize."

The analytical procedures proposed in this Report are aimed principally at industrial plants that are direct dischargers. In most of these sectors, there are between 7 and 30 plants operated by somewhat fewer companies in each sector. However, in the Metal Mining and Refining Industry and Industrial Minerals sectors, between 50 and 115 establishments are subject to the Regulations.

Cost estimates would be generated on a plant-by-plant basis for each sector. Financial and economic assessments would be carried out at an appropriate level in each sector, subject to the availability of data.

At this time it is intended that the same analytical procedures will be applied to indirect industrial dischargers which release their wastewaters into municipal sewers. However, there are many more establishments and firms in this category than in the direct discharger grouping. Consequently, analyses of the economic costs and consequences on indirect dischargers should have to be carried out on representative plants and firms within each industry. The results of these analyses can then be extrapolated to the remaining firms and aggregated accordingly.

The Ministry's MISA Municipal Section staff are currently collecting data on indirect industrial dischargers that will be of use in these analyses.

As noted, Chapters 1 - 3 provide background and supporting material. Chapters 4 and 5 discuss the procedures and criteria involved in economic achievability assessments for the MISA abatement phase. Accordingly, the issues raised and assumptions made in the remainder of this Report are summarized below.

1. Abatement cost functions should be developed for different levels of BAT to display the relationships between different levels of contaminant removal and the minimum cost of achieving them, through the JTC working groups.

2. Where possible, costs should be estimated for at least four cost-effective BAT options for each plant.

3. Economic assessments of the MISA program should not include non-environmental regulatory costs. The government and public should, however, be aware of and consider the cost of additional government policy initiatives.

4. Previous costs of environmental protection and pollution abatement systems at plants subject to MISA requirements should be assembled where possible and considered in the development of abatement cost functions for the sectors. Such costs should not be added explicitly to the relevant MISA costs in the proposed economic assessments.

5. Costs of present environmental regulatory initiatives and mandated requirements other than proposed MISA regulations should be considered in assessments to the extent possible, recognizing limitations in capital availability.

6. Information needed to develop cost estimates for each relevant BAT option are listed; it is assumed that the relevant information would be assembled through the JTC.

7. Private benefits should be enumerated and valued so as to determine the net costs of each BAT option that is analyzed.

8. Annualized costs or discounted present values should be used to permit comparison of capital costs or payments at different times.

9. Historical data and future costs should be adjusted for inflation, so that comparisons would be based on constant dollars.

10. A maximum time horizon of ten years should be assumed for the purposes of the analyses (including the period from which historical financial indicators may be considered), unless a longer period is judged appropriate. This time horizon applies to both historical financial indicators and to future costs and market assessments.

11. Conventions should be established to compute cost effectiveness when abatement technologies or BAT options remove more than one pollutant at a time.

1. Analysis of economic achievability can provide a framework for analyzing the impacts of potential BAT costs, but it cannot determine a unique or unequivocally accepted choice from among the BAT options.

2. While net costs are to be estimated on a plant or establishment-specific basis, analyses of economic effects would be carried out at the level of the firm, industry, and/or at the individual plant level, as appropriate and if data are made available. The onus to bring this information forward is on the affected firm. In the absence of more disaggregated data, firm-level, publicly available data would be used for the financial assessments.

3. Information on market structure of the various industrial sectors should be analyzed to indicate the extent to which firms must absorb the extra net costs as reductions in net profit and returns or would be able to pass all or part of their net incremental compliance costs onto their customers as higher prices or to suppliers by extracting price concessions. The effects on international competitiveness, as measured by sector norms, would also be considered.

4. For purposes of the analyses, it should be assumed that no financial assistance will be available from government, other than existing tax policy such as sales tax exemptions and accelerated capital cost allowances.

5. The analyses and tests defined in Chapter 5 would be applied, as appropriate, to the particular BAT options and their net costs that are implied by a proposed MISA Effluent Limits Regulation for each industry; they may also be applied to alternative BAT options. In any sector, the list of analyses and tests may be expanded.

6. The impacts of estimated costs on economic indicators and tests would be assessed for worst, average and best years, during the time horizon analyzed.

7. Economic and financial consequences would be assessed for the plant as data are available, individual firms, industrial sectors and the provincial economy as a whole; possible disparities of effects between large and small business and between regions within the province should also be examined.

8. To the extent possible, analyses should explicitly show distribution of various effects on the relevant segments and groups in Ontario.

9. While there are no widely agreed upon distinct threshold values for any of the performance indicators cited in Chapter 5, three ranges of outcomes can be provided: adverse impacts quite unlikely, adverse impacts quite likely, or impacts uncertain. Consequently, criteria are proposed to allow judgement of the consequences of the proposed Limits Regulation.

2.0 BACKGROUND

This chapter provides a review of recent applications of economic and financial analyses for environmental policy in Ontario and elsewhere.

2.1 Ontario Experience

The Ontario Ministry of the Environment (MOE) has in place formal policies for the inclusion and consideration of economic factors in all program initiatives. These policies[2] articulate the Ministry requirement that an economic and financial analysis may be invoked during the development of abatement requirements for individual firms and in the preparation of new programs, policy proposals, Regulations or legislation.

Over the past fifteen years, Ministry staff and/or consultants have carried out at least 17 detailed financial assessments in support of Control Orders and other regulatory initiatives, and in some of these cases, the company position was borne out. The purpose of performing economic analyses is to generate information about the financial and economic consequences of proposed programs or requirements. The results of these economic analyses are one factor used by the Minister and Ministry personnel in their decision-making.

"Economic analysis" is defined in MOE policy as the "application of economic principles to identify and evaluate the consequences of particular course of action or changes in policy. The quantitative magnitudes of all relevant consequences are estimated, monetary values that are associated with these effects are assigned (where possible) and the incidence or distribution of these consequences and values among different groups, economic sectors and/or regions is determined"[3]. Economic analyses clearly display quantitative and qualitative information about the consequences of an action and which can be used to make informed choices. Benefits of programs are to be identified as well as the costs[4].

MOE Policy 02-01 further outlines criteria and procedures to be used to evaluate a firm's ability to incur the costs of implementing regulatory requirements. They include, but are not limited to:

(a) calculation of financial performance indicators, including the expected compliance costs;

(b) magnitude of employment impacts and other social consequences of compliance; and

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[2]MOE Policy Manual, Policies 02-01, 02-02, and 02-03.

[3]MOE Policy 02-01.

[4]MOE Policy 02-02.

(c) comparison of the present value of expected future profits with compliance costs with the salvage value of the plant or other relevant assets.

If such economic analyses indicate that compliance with regulatory requirements will impose undue economic or financial hardships, more comprehensive economic analyses, such as cost effectiveness and/or benefit-cost analyses may be required. Firms who claim undue burden are expected to provide the necessary data and other information to substantiate their claims.

2.1.1 MISA Economic Analyses To Date

Building on these policies, Ministry economists prepared reports for the monitoring phase of MISA. For each of the nine industrial sectors subject to MISA monitoring requirements, two economic documents were prepared. The first presented an economic profile of the relevant sectors. A second report contained detailed cost estimates of the proposed monitoring regulation together with an evaluation of the economic impacts, or the "economic achievability", of these requirements[5].

Economic Profiles

The industrial economic profiles included the compilation of physical and economic data, financial performance ratios, current trends, and forecasts of future market production and consumption trends. These profiles were limited to publicly available data, normally available at the firm or corporate level. Published data are generally unavailable for most plants, and for firms in Ontario which are privately owned and/or subsidiaries of larger, multi-national parent companies. Despite such limitations, the profiles were, at the time, a best-available source of information for the development of economic databases upon which the potential impacts of MISA monitoring and abatement requirements and their costs could be assessed.

Cost of Monitoring Reports

The MISA "cost of monitoring" reports were prepared in order to provide plant-specific cost estimates based on the monitoring schedules for each sector and each plant in a sector. Estimates of capital and operating and maintenance (O&M) costs were derived for each monitoring activity defined in the monitoring regulations.

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[5]For a full description of the MOE economic assessment program for MISA, see Salamon, Orna E. and Donnan, Jack A., "Economic Assessments of MISA Regulations for Direct Industrial Dischargers in Ontario", Proceedings of the 1988 Technology Transfer Conference, Toronto.

See also MOE, Economic Needs and Assessments for Developing MISA Monitoring and Abatement Requirements, March 1987.

Representatives from each industrial sector participated in the development of cost estimates, and many industrial representatives offered useful comments and corrections to the draft economic assessment reports. Given the estimated levels of expenditure, no firm insisted upon more detailed analyses.

All of the firms subject to the MISA regulations were asked by the Ministry to provide plant-specific financial data. However, all subject firms declined, stating that such information was difficult to assemble and could be proprietary in nature. Therefore, using only published data and other information from the sector economic profiles, the financial and economic impacts likely to result from the costs of imposing monitoring requirements were assessed. The costs and consequences of alternative monitoring options were also derived, and all the estimates and evaluations were used as inputs to the deliberations of the JTCs.

Summaries of these economic analyses were incorporated into the Development Document for each sector. Draft versions of the economic studies and development documents were issued for public review and comment prior to the finalization of each monitoring regulation. The preparation of such economic assessments provided information of interest to the regulated plants and firms, to the public, and to other ministries as part of the government review process.

Firms subject to the MISA monitoring regulations had ample opportunity to review these cost estimates and economic analyses consistent with MOE policy 02-01, and, if they desired, challenge the assessments and calculations.

Future Action

As a follow-up, the Ministry will circulate a questionnaire to all plants and firms subject to MISA monitoring Regulations to assemble the actual costs of monitoring that were incurred. The results will, among other things, serve as a guide for future cost estimation efforts and economic analyses by the Ministry.

2.1.2 Other MOE Initiatives

Economic analyses are conducted for all major Ministry initiatives. For example, a systematic program of socio-economic assessments was developed and implemented in the 1970s in support of the Ministry's Acid Precipitation Program. Information from these assessments were utilized during Canada-provincial deliberations for an acid deposition control program. Ontario's Countdown Acid Rain program was a key result of these negotiations.

A second example involves a series of socio-economic studies which were carried out by consultants in support of proposed revisions to the air quality management requirements under Regulation 308 of the Environmental Protection Act (EPA). These studies derived estimates of capital and operating costs of alternative implementation

scenarios. The financial and economic impacts for plants, firms, regions and the economy as a whole, were assessed. Public benefits of the proposed revisions, in terms of reduced corrosion, public health risks and other adverse effects were also estimated and values ascribed to them.

Another program of the Ministry involves imposing waste management initiatives on all sectors of Ontario society. By the Year 2000, it is intended to divert at least 50% of total wastes from landfills and incineration to recycling or recovery. In order to help design these programs as well as to provide supporting documentation to central agencies, another series of socio-economic studies is underway to analyze costs and benefits of alternative scenarios.

These and other economic assessments build upon economic theory, formal Ministry policies, previous economic studies and assessments by Ministry economists, as well as experience in other jurisdictions. Some of these assessments evaluated the financial and economic consequences of proposed environmental protection requirements while others estimate and compare the incremental benefits and costs of different levels of environmental protection. Each of these assessments help decision-makers make informed choices about environmental objectives and policies.

2.2 United States Experience

The term "best available technology, economically achievable" (BATEA) appears only in the U.S. Clean Water Act (CWA), where it is stated that "effluent limitations for categories and classes of point sources" are to be achieved which will require "application of the best available technology economically achievable for such category or class"[6]. Normally, such class-wide determinations would be made through a Regulation rather than the issuance of a permit to one member of the class.

Effluent limits for a particular plant may be relaxed if the owner of a plant shows that "such requirements (1) will represent the maximum use of technology within the economic capability of the owner or operator; and (2) will result in reasonable further progress toward the elimination of discharge of pollutants"[7]. This has been interpreted to show that effluent limits (or abatement requirements) are to be established prior to the consideration of the characteristics of a particular plant. Furthermore, it shows that BATEA does not refer to an individual plant, but to a class of similar plants. However, in most cases, BATEA was applied at the individual plant level.

The authority to consider the economic consequences of regulatory requirements is further noted in other statutes and executive orders, as summarized in Table 2-1.

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[6]U.S. CWA, Section 301(b)(2)(A). [Peat Marwick (DRAFT)]

[7]U.S. CWA, Section 301(c). [Peat Marwick (DRAFT)]

TABLE 2-1MAJOR U.S. ENVIRONMENTAL STATUTES

STATUTE	KEY PHRASE	REFERENCE
CLEAN WATER ACT	ECONOMICALLY ACHIEVABLE	SECTION 301(b)(2)(A)
CLEAN AIR ACT	TECHNOLOGY FORCING	SECTION 202(a)(2)
SAFE DRINKING WATER ACT	NO KNOWN OR ANTICIPATED EFFECTS ON THE HEALTH OF PERSONS	SECTION 101(b)(4)
TOXIC SUBSTANCES CONTROL ACT	UNREASONABLE RISK OF INJURY TO HEALTH OR THE ENVIORNMENT	SECTION 6(a)
RESOURCE CONSERVATION RECOVERY ACT	PROTECT HUMAN HEALTH AND THE ENVIRONMENT	SECTION 3002(a)
COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATIONS AND LIABILITY ACT	SUBSTANTIAL DANGER TO THE PUBLIC HEALTH	SECTION 102(a)
FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT	UNREASONABLE ADVERSE EFFECTS ON THE ENVIRONMENT	SECTION 3(c)(5)(C)

SOURCE: Peat Marwick (DRAFT), p.19.

Despite the popularity of the term, BATEA, and the references to its consideration in other statutes, nowhere are BATEA or similar terms defined in U.S. EPA documentation. However, based on the U.S. Congressional record and the language of the CWA, the U.S.

EPA has interpreted the Acts to mean plant closures and job loss[8] are the primary measures of "economic achievability" for private sector regulated parties. In practice, the U.S. EPA has used a variety of financial measures as predictors of plant closures and job losses. It is important to note that such measures differ for the private and public sectors[9].

Economic impact studies of proposed regulations on private industrial sectors included calculation of the effect of incremental compliance costs on the financial statements of affected firms and, where data were available, on the cost structures of individual plants. The potential number of plant closures were inferred from these calculations.

Assessments in the United States are often tailored to focus on small business[10]. The analytical framework is not changed, but impacts on small business are identified and the implications of less stringent control requirements for small firms are discussed.

U.S. EPA economic studies employ financial ratios and cash flow analyses to estimate economic impacts. These financial ratios are grouped into four categories: **profitability** (how well a firm is performing in generating profits), **solvency** (the amount of debt carried), **liquidity** (ability to meet short-term obligations), and **efficiency** (extent to which assets are not wasted). The U.S. EPA determined that the economic assessment methodologies should meet three criteria: (i) strong empirical justification; (ii) threshold values derived from recent data; and (iii) simple, consistent application to available data sources[11]. Three financial ratios were found to satisfy most of these criteria: **return on assets, total debt to total assets**, and **cash flow to total debt** ("Beaver's ratio").

A frequently used approach for the estimation of potential plant closures is **discounted cash flow analysis**. Here, the streams of future profits, before and after pollution control expenditures, from a plant are calculated and then discounted to today's dollars ("**present value**"). These values are compared to the estimated salvage value of the plant. If the salvage value is higher than the discounted profit stream after incurring pollution control, it is expected that the owners would consider closure. This approach, while theoretically attractive, has formidable data requirements as well as the need to make a large number of assumptions which differ for each industrial sector under consideration. Such analyses also tend to exclude consideration of the short-term business cycle effects.

2.3 Information Needs

The preparation of economic analyses cost over half a million dollars for each sector subject to the U.S. CWA. Each undertaking employed data from many sources at

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[8]Peat Marwick (DRAFT), p.19.

[9]Peat Marwick (DRAFT), p.19.

[10]Peat Marwick (DRAFT), p.55.

[11]Peat Marwick (DRAFT), p.21.

varying levels of aggregation. Where possible, firm and plant-specific data were used. In cases where such data were not available, aggregate and/or publicly available data were substituted.

Under Section 308 of the U.S. CWA, the U.S. EPA has the authority to conduct a survey to collect technical, financial, and economic information[12]. When firms objected to requests for financial data, the U.S. EPA removed them for several subsequent sector surveys. The Agency has therefore tended to rely heavily on publicly available sources for financial data, such as annual reports and financial services like Dun & Bradstreet for most EA studies on individual sectors.

Another method used in the United States to overcome data deficiencies was the "**model plant**" concept, wherein pro-forma financial statements (i.e. balance sheets and income statements) are estimated from aggregate data to characterize "representative plants" within a sector or subsector. While a model plant approach may be useful where appropriately homogeneous sector subcategories can be defined, differences between firms within the same category may not be realistically captured.

Industry submissions submitted as part of the regulatory process in the United States forecast serious economic consequences as a result of proposed Regulations. However, no industry-sponsored *ex post* studies of economic effects, that either disputed the forecasts or demonstrated significant economic disruptions as a result of the regulation of toxic pollutants, have been identified[13]. This can be attributed to a number of factors, such as the iterative nature of negotiation during the Regulation development process, the ability of industry to absorb costs, and the extent of public consultation involved in the process. The final Regulations can be viewed as acceptable to industry as well as improving environmental quality.

2.4 "Economic Achievability" in Other Jurisdictions and Contexts

According to available literature, "economic achievability" considerations are addressed in a number of ways in OECD countries outside of North America[14]. Terminology related to the concept of EA includes "affordability" and "without excessive costs". While such concepts have been considered in the definition and enforcement of environmental standards, they have not been operationalized in a way to permit the identification and application of specific EA definitions.

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[12]Peat Marwick (DRAFT), p.28.

[13]Hickling (1990), p.II:6-7.

[14]Peat Marwick (DRAFT), p.46.

Elsewhere in Canada, the concept of economic achievability has generally not been formally defined or applied[15]. In several provinces, such as Quebec and Alberta, the evaluation of environmental regulations considers costs, benefits and distributional effects. These are neither as well developed as in the United States nor are they consistent across Canadian jurisdictions.

Lastly, the concept of "economic achievability" exists for non-environmental applications[16]. In these applications, while the conceptual framework used to address EA considerations is similar to that used by the U.S. EPA, these concepts are not defined in statutes or regulations. It appears that the environmental field is the leader in defining and applying EA concepts. An exception to this observation is in the area of Trade Remedy Law, where there is an established practice that deals with "material damage".

2.5 Application of the U.S. Experience to Ontario

A wholesale adoption or transfer of the U.S. approach and experience for EA analysis is not feasible without explicit consideration of the following limitations:

- Data availability. While many authorities argue that analyses should be directed at the plant level, such data rarely exist in a publicly available form, either in the U.S. or Canada. Unlike the U.S. EPA, Ontario legislation does not allow for a survey of firms in order to obtain required information.

- Size of economies. The smaller size of the Canadian and Ontario economies in relation to the U.S. statistically limits the number and scope of analyses used to define "model plants" and other means by which data gaps were closed. There are also relatively few public single-industry (i.e. operating in only one market), and fewer single plant, firms in the MISA-defined sectors. The mapping of model plants onto a larger sector is further limited by the small number of firms and plants subject to MISA regulations. The economic and financial consequences of abatement costs on Ontario industry could be relatively more severe that the U.S. experience given the smaller industrial base on a sectoral basis.

- Subsidiaries. There are many firms in Ontario that are owned by foreign and domestic conglomerates. Unlike single plant companies, financial data, even if publicly available, may reflect internal corporate considerations rather than plant level economics.

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[15]See Peat Marwick (DRAFT) and Hickling (1990) for further analyses of inter- and intra-jurisdictional approaches.

[16]See Peat Marwick (DRAFT), pp.46-53 for a more detailed discussion.

- Threshold values. There do not appear to be studies which identify appropriate thresholds which can be used as indicators of undue economic burdens. The U.S. EPA studies do not provide rationales for their use or levels of threshold values in their sectoral economic analyses.

2.6 Conclusion

The experience from the United States indicates that there is no clear, consistent definition of "economic achievability" or a framework within which to apply the concept. "BATEA" appears only once in a U.S. statute (the Clean Water Act), which does not offer a definition of the term. The U.S. EPA has interpreted EA as plant closure and job loss, and uses a variety of methods in order to forecast changes in these indicators as a result of environmental requirements. However, there does not appear to be a "process" by which EA has been determined in all sectors subject to water quality abatement regulations.

In Canada, Ontario has specific policies and guidelines for economic analyses. The Ministry of the Environment has conducted many analyses of the financial and economic effects of pollution control requirements on individual plants, firms and industries. These assessments are not inconsistent with the U.S. approach and concept of "economic achievability".

3.0 ECONOMIC PRINCIPLES AND RATIONALE FOR ASSESSING ECONOMIC AND FINANCIAL CONSEQUENCES OF MISA-RELATED POLLUTION CONTROL ACTIVITIES

The ultimate goal of the MISA Program is the virtual elimination of persistent toxic contaminants from our waterways. Progress toward this goal is to be achieved sequentially through periodic tightening of effluent limits following periodic re-examinations of abatement technology, industry abatement standards and quality of the receiving body of water for the major industrial sectors and the municipal sector.

Within the framework of the MISA program, difficult choices have to be made regarding how far contaminant reduction will proceed, and how fast. Theses choices involve a variety of considerations-- scientific, legal, political, engineering and economic-- and therefore tradeoffs.

Economics is the study of how individuals and society choose to employ scarce productive resources among alternative uses, in order to (1) produce goods and services over time and (2) distribute them for use and enjoyment among various people and groups in society. Economic principles can provide information useful for making choices concerning the MISA program in a number of ways.

First, economics can inform interested parties about the costs to society of different pollution control options. These costs represent the value of the resources that must be channelled into controlling pollution and that will not be available for meeting the other wants of Ontarians.

Second, the incremental costs of achieving increasingly stringent levels of pollution reduction will be shown. This information will illustrate major "breakpoints" where large cost increases yield little additional reduction of pollution.

Third, an important criterion for the development of MISA effluent limits regulations is that contaminant reduction be accomplished at the lowest possible economic cost. Economic analysis can help to identify the least costly way to accomplish a reduction level. This approach is commonly referred to as cost-effectiveness analysis.

Fourth, economics can help to understand how the costs of MISA requirements may be distributed among the population of Ontario. For instance, it will be determined whether plants or workers in certain parts of the province are disproportionately affected by the regulatory requirements. Also of interest is the distribution of consequences of the requirements among small and large businesses.

3.1 Analytical Approaches

Economic analyses have two distinct but interrelated aims. One aim is to understand and model the economy as a whole and its various components. This aim is carried out by describing economic activity, including linkages between industries, markets

and sectors, and by measuring relevant economic variables. Measurement of economic variables provides an historical record and a basis for assessing the current state of the economy. Economic models provide a basis for forecasting future conditions and for evaluating the consequences of alternative policy measures or structural changes. Descriptive and evaluative economic analyses are referred to as *positive economics*.

A second aim of economic analyses is to contribute to policy choice and the designation of decision rules. Because choices between policy or program options generally involve tradeoffs, there is unlikely to be a single option which is unequivocally preferred by all parties. However, decision rules can be defined to embody particular criteria, and which specify the courses of action that are desirable. Assessments of "what ought to be" are termed *normative economics*.

Cost-effectiveness analysis and financial impact analysis are approaches often applied to economic policy evaluation. The intent of cost-effectiveness analysis is to ensure that a specific objective is achieved at the lowest possible cost. The intent of financial impact analysis is to determine the distribution of the potential economic and financial effects of estimated costs and assess their implications on the performance of the firms that bear the costs and on the purchasers of the affected products. These and other approaches can be applied jointly as components of an assessment of economic achievability.

These analytical tools are applications of positive economics in that no decision rules are prescribed. Only the consequences of the imposition of costs are displayed. However, these analytical tools also have a normative aspect in that they provide a basis for reducing the number of potential BAT options.

3.2 Implications of Cost Increases

Additional costs imposed by more stringent pollution control measures will increase production costs for the affected plants and products. At the same time, the changes in production and pollution control technology and equipment, and in management practices, may give rise to some efficiencies and cost savings. In the subsequent discussion, references to additional costs will imply additional costs net of any concomitant private benefits to the plants. To varying degrees, the incremental costs may be passed along to consumers of the products as higher prices, passed back to workers and other suppliers of inputs as lower wages and input prices, or absorbed by owners in reduced profits.

Some of the additional costs may represent additional revenues for other sectors in Ontario, such as the environmental protection industry. In this sense, they reflect transfers of income from one group to another. However, other expenditures may leave the province and country through the purchase of goods and services from outside the province.

The additional costs may induce some owners to discontinue operations at a plant and/or declare bankruptcy. Closure of a plant can result in a loss of income to its owners,

employees and other suppliers, and in higher prices to consumers. However, in the event that the plant and other assets are sold, losses may be mitigated or avoided altogether. Any such losses should be weighed against the corresponding gains in environmental quality.

3.3 Implications of Market Structure

The distributional effects of incremental costs of pollution control will depend in large part on the market structure faced by the private firms or crown corporations for their products. Market structure has been studied at great length as part of the field of economics known as industrial organization.

Cost increases can be more easily passed along to consumers to the extent that a firm has a greater degree of monopoly power in its product market (i.e, when a seller faces limited competition from other suppliers of its products). Likewise, cost increases can be more easily passed back to suppliers to the extent that a firm has a greater degree of "monopsony" power (i.e., when a buyer faces limited competition from other purchasers in dealing with its suppliers).

A competitive market consists of large numbers of producers and consumers of homogeneous products. Each producer supplies a small share of the total market sales and cannot raise its prices independently. However, prices would rise if a significant number of the firms were subject to higher costs. Cost increases could be passed on to consumers in higher prices as more firms in the industry are subject to higher costs. However, if only a few firms in a market incur higher costs, owners of these firms will likely to experience reduced profits.

Monopolies are markets that have a single supplier of a product. A monopoly can generally pass through incremental costs as higher product prices. However, even a monopoly may experience reduced sales and profits if consumers cut back on purchases as a result of higher prices. Effects on employment and income to workers in and suppliers to a monopoly firm are difficult to predict, so that a careful assessment will require empirical analysis.

Oligopolistic markets have a small number of suppliers. Each firm in such a market can generally pass through incremental costs as higher products prices. However, such firms are constrained both by the amount that consumers are willing to pay and by strategies employed by other firms in the market.

Monopsonistic markets have a single purchaser of a commodity. A single-industry town is an example of a monopsony in a labour market, while a major pulp mill may be the only buyer of wood chips in a particular market. Owners of the regulated plant would likely bear a smaller percentage of any additional costs, and suppliers to the monopsony would bear a larger percentage than under competitive conditions.

Various measures of market concentration have been used in economic analyses, such as the sales of the four or eight largest suppliers in the market as a percentage of total sales. Previous studies could serve as a source for determination of market structure and monopoly power or as context for comparing JTC calculations of standard measures of concentration. However, care must be exercised in the application of earlier studies to ensure that the trend toward expansion of international trade is taken into account.

Economic and financial profiles of the MISA industrial sectors which were prepared for Policy and Planning Branch in 1987 provide descriptions of market structure and international competitiveness for each industry. These factors are also addressed in industry sector profiles that are being prepared by the Ministry of Industry, Trade and Technology.

4.0 COST ESTIMATION PROCEDURES

4.1 Purpose of Chapter

In this Chapter, procedures for developing cost estimates of defined BAT options for private sector and crown corporation direct dischargers will be presented. Relevant terms will be defined and cost conventions for calculating, analyzing and displaying cost estimates will be proposed. Procedures for developing least-cost "abatement cost functions" for individual plants and industrial sectors will be described. Such cost functions should be the primary tool for analyzing the consequences of different levels of pollution abatement and serve as input to economic achievability assessments. Links and overlaps with other issues will also be noted.

Estimation of the costs of achieving different levels or degrees of pollution abatement prior to the formulation of the regulation is a significant departure from the approach taken in the analyses of the costs of MISA monitoring regulations. Although attempts were made to determine the cost of alternative monitoring programs, the focus of each "Monitoring Cost" report was certainly on the cost of the one configuration of monitoring specified in the regulation for that sector (for example, see the Pulp and Paper Sector report: Ontario Ministry of the Environment, 1989).

4.2 Abatement Cost Functions

Abatement cost functions are relationships between different levels of contaminant removal at a pollution source and the minimum cost of achieving them. These relationships may be displayed in graphs or tables. In general, the greater the degree of abatement, the higher the costs to be incurred. Each level of contaminant removal or abatement implies the application of one or more "abatement technologies" upon which costs are estimated. An "Abatement Technology" includes in-plant process changes, best management practices, as well as add-on, end-of-pipe treatment technologies.

Conceptually, cost functions can be developed for different levels of aggregation. Two levels are of interest for each JTC:

1. *Plant level:* the relationship between the levels of removal for specific pollutants from a single plant and the minimum cost of attaining each level;

2. *Sector level:* the relationship between the levels of removal for specific pollutants from all plants from a particular industrial sector, taken together, and the minimum cost of attaining each level;

In addition, a third level can provide a useful input to decision-makers. An *economy-wide* level illustrates the relationship between the total levels of removal for specific pollutants from all plants (in different industries) that emit them and the minimum cost of attaining each level of abatement.

Abatement cost functions display what can be achieved in terms of pollutant reductions for given increments of cost.

The presentation of cost functions is usually two dimensional in that costs and reductions are shown for one pollutant at a time. Where more than one pollutant of interest is removed by specific technologies, computation of cost functions and display of results are more complicated. Procedures are available to deal with this situation, and are discussed later in this chapter.

As will be demonstrated in more detail, abatement cost functions generally display only the **least-cost** combinations of technologies to achieve specific degrees of removal or final loadings. Analyses of industrial pollution abatement programs invariably reveal many combinations of abatement technologies that can achieve specific levels of pollutant removal[17]. In this report, the least-cost combination of compatible abatement technologies to achieve a given degree of pollutant removal is referred to as a **"cost-effective BAT option"**.

A primary objective of the abatement cost estimating exercise for each JTC should be to develop cost functions that include at least 4 levels of water pollution abatement beyond the existing level of pollutant discharges in a plant and the industry. These levels of abatement would include scenarios as directed by the sector JTCs.

The information provided by these estimates would then be used to evaluate the cost implications of incremental changes in abatement and would serve as input to Economic Achievability assessments.

4.3 Costs of Other Regulatory Requirements

Industrial firms are often subject to other regulatory requirements by the Ministry of the Environment and by other governmental agencies for purposes of workplace health and safety and/or consumer protection. These regulatory requirements may also impose costs on the same firms that will be liable to the proposed MISA regulations.

As noted, it would be ideal to evaluate the implications of a comprehensive set of costs resulting from all relevant regulatory requirements on eligible firms. However, reliable cost estimates for regulatory requirements other than environmental protection are not readily available. Moreover, the Ministry of the Environment has no control over such requirements and their costs.

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[17]Abatement cost functions are discussed in Donnan, et al. (1986). Applications of abatement cost functions are presented in Ontario Ministry of the Environment (1987) and VHB Research & Consulting Inc. (DRAFT 1989). The latter study, which applies abatement cost functions to reductions in emissions of air pollutants, is discussed in the Appendix to Chapter 4.

Previous investments on environmental protection and pollution abatement systems at plants subject to MISA requirements should be assembled where possible and considered in the development of abatement cost functions for the sectors. However, such costs should not be added explicitly to the relevant MISA costs in the proposed economic assessments. The effects of such investments have already been incorporated into a firm's financial performance indicators and so would be taken into account in the assessments of expected new environmental expenses. Past operating costs for environmental protection should have been taken into account in a firm's balance sheets and income statements.

Costs of present and future environmental regulatory initiatives and mandated requirements other than proposed MISA regulations would be considered in assessments to the extent possible, recognizing limitations in capital availability. For example, if:

a. The requirements are specifically mandated by an existing legal instrument (eg. Control Order, Certificate of Approval),

b. The proposed expenses have not been incurred, and

c. Acceptable cost estimates have been prepared by the Ministry or by regulated parties.

4.4 Cost Estimation Procedure and Information Requirements

To the extent possible, abatement costs for relevant BAT options should be estimated for individual plants subject to the MISA regulations.

Costs of achieving 4 or more abatement levels should be estimated for each plant. Where the technology exists, costs would be determined for total contaminant removal. Where the technology for total removal does not exist, costs would be determined for the maximum achievable removal of contaminants. Under certain circumstances, the additional costs of removal of individual contaminants may be considered. These cost functions can be used to develop a sector-level cost function for specific pollutants. Plant-specific cost estimates would be added together, as appropriate and as data are available, to obtain total costs associated with individual firms or industrial sectors.

The following types of information should be assembled by the JTC for each sector to develop cost estimates for each relevant BAT option:

a. Identify technology or combination of compatible technologies included in the BAT option according to rules developed by the BAT Issues Resolution Committee.

b. Pollutant removal efficiencies (stated as percent removal) for each type of pollutant that can be removed or processed by the BAT option, and any variables that may affect the efficiencies (e.g., concentration in the effluent, temperature, etc.). Operational reliability is incorporated into the definition of a BAT option.

c. Capital costs relevant to the type and scale of each abatement technology at the plant capacity, as specified by the individual firms, of the regulated plant included in the BAT option. Capital costs should be disaggregated into:

   i. engineering and planning,

   ii. construction and installation, including retrofitting,

   iii. equipment and machinery,

   iv. land acquisition.

d. Operating and maintenance costs, including monitoring, for a typical year. Where possible, enumerate labour requirements associated with each BAT option in person-years of effort.

e. Operating life of abatement technologies, in years.

f. Minimum installation time, in years, of BAT option equipment, and the extent to which rapid installation may affect costs or reliability of the equipment.

g. **Private Benefits** of each BAT option, including reduced energy or materials inputs, saleable by-products, reduced labour requirements, enhanced production efficiencies or improvements to product quality. These benefits and their potential annual totals should be displayed separately but then subtracted from relevant costs to determine **Net Costs**.

h. Wastewater flows and concentrations of pollutants of interest in streams prior to the application of abatement technologies. Final effluents and pollutant reductions to be expressed as loadings (i.e. mass per unit time).

Total capital and O & M costs for each BAT option would be estimated by adding the relevant capital and O & M costs for each component abatement technology. Where uncertainties may exist, sensitivity analyses may be undertaken.

In order to compare or to sum net costs among plants, cost estimates should be be converted to either **annualized costs** or to **discounted present values**. Such conversions permit one-time capital expenditures for equipment that lasts for a number of years to be considered simultaneously with annual operating and maintenance expenses. Also, costs should be expressed in constant dollars to abstract from the consequences of inflation. Such adjustments and conversions permit the comparison of expenditures occurring at different times.

Annualized costs can be computed by multiplying capital costs by an appropriate annualization factor based on an interest rate and the life-time of the relevant abatement technologies. This annualized cost is then added to the typical annual O & M cost.

Present values are calculated by multiplying both annual O & M costs and capital expenses that would be incurred over a relevant time horizon in the future by relevant present value factors. Present values of future O & M and capital costs are then added to expenditures that would be incurred during the current year.

The maximum time horizon proposed for these computations is 10 years, or longer if appropriate.

4.5 Cost-Effectiveness Analyses

For each BAT option, a cost per unit of pollutant removed should be calculated. The cost figure used in this ratio would be the annualized or the present value figures, as is appropriate. The unit of pollution removed would be the mass in kilograms or tonnes per year (eg. annualized cost/tonne pollution reduced per year).

These ratios can be computed for different BAT options applicable to each direct discharger plant. Cost effectiveness ratios may have to be computed for more than 4 potential BAT options to find a least-cost set.

Cost-per-unit pollution removed ratios can also be compared for the various plants in each sector or subsector. A sector or subsector cost function can also be constructed which relates the total cost required for the sector or subsector to achieve different degrees of total pollutant removal.

(Sub)Sector cost functions can be derived under the assumption that all plants within the (sub)sector face common effluent limits. Alternatively, limits could be assumed to differ between plants in a way that achieves each target level of total effluent removal at minimum cost to the (sub)sector. Comparison of the cost functions derived under these two assumptions would indicate the potential for reducing the total (sub)sector cost of achieving alternative levels of effluent removal.

As noted, plant level or sector level abatement cost functions can be used to evaluate the cost differences of different strategies for setting contaminant loading strategies.

When abatement technologies or BAT options remove more than one pollutant at a time, there is no objective means of apportioning the costs of removal among each pollutant. This means that we cannot assign a unique cost to the quantity of each pollutant removed. A convention must be established to compute cost-effectiveness ratios for these "joint costs". The following approaches could be used in these situations.

a. The total mass of pollutants removed by each BAT option would be summed and used as the numerator in calculating the cost-effectiveness ratio.

b. Weights would be assigned to each pollutant prior to summation. They can be based on priorities assigned to each pollutant by other schema. (The so-called "copper standard" appears to be such a weighting scheme.)

This procedure would derive cost functions showing the cost-reduction combinations for a single "parameter" which is the weighted or unweighted sum (in kgs or tonnes per unit time) of all pollutants removed. The weighting procedure will have the effect of reducing the cost per unit removed of BAT options that reduce parameters with high weights (eg. 1). BAT options that reduce parameters with low weights would appear to have higher per unit removal cost ratios in the cost-effectiveness analysis.

Another complicating factor in cost-effectiveness analysis is the measure of toxicity. Toxicity is not measured as a mass/unit time removal and so cannot be summed with other pollutant parameters. Various approaches can be taken to assess the cost effectiveness of BAT options with respect to toxicity. For example:

1. Toxicity units derived from the toxicity tests can be used alone as the pollutant parameter (denominator) in the cost per unit removal ratio.

2. Use a surrogate parameter that can be measured in mass units in place of toxicity. Such a parameter can be weighted and then added to other pollutants, if necessary.

4.6 Summary

Cost estimation procedures are intended to produce least-cost abatement cost functions for each plant in each industrial sector. Abatement cost functions display the costs of achieving incremental reductions in specified pollutants.

Pollutants should be expressed as loadings (i.e. mass per unit time) prorated to the plant capacity as specified by the individual firms for the regulated plant.

Different expressions of cost that would be generated in the course of this activity include "annualized costs" and "present values" of costs. Private benefits of pollution abatement investments to the regulated firms, including reduced inputs and energy

requirements, saleable by-products recovered, reduced operating costs, etc., should be explicitly enumerated, valued and displayed. Net costs would then be computed for use in other analyses.

Abatement cost estimates for each plant can be used to estimate cost functions for the industrial sector under study or for total reductions of a particular pollutant which is generated across industrial sectors. Total costs of specific target levels of pollutant reductions can then be computed as well.

Cost-effectiveness analyses would be applied to determine the least-cost BAT options to achieve specific levels of pollutant reductions. The procedure involves computing the cost per tonne or kilogram reduced for BAT options in individual plants and comparing them to find the least-cost options.

Cost-effectiveness analyses are complicated when more than one pollutant is reduced by a technology or a BAT option and when pollution parameters are measured in different units. Conventions for carrying out cost-effectiveness computations under these conditions are proposed.

These procedures are illustrated in Figure 4-1. As shown, the information generated by these procedures are necessary inputs to the assessment of economic impacts on firms that must implement abatement. This topic should be taken up in the next chapter.

ABATEMENT COST FUNCTION DEVELOPMENT

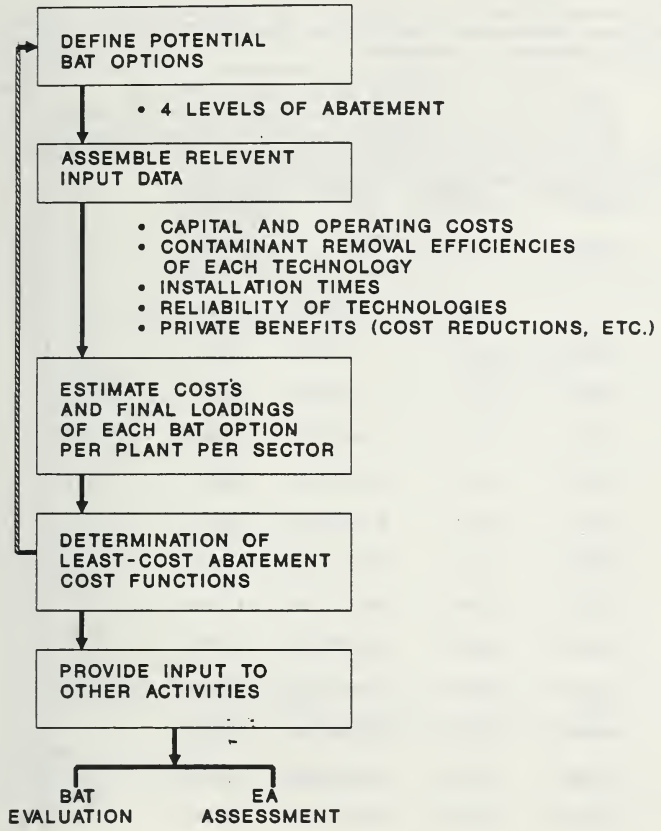

DEFINE POTENTIAL BAT OPTIONS
• 4 LEVELS OF ABATEMENT
ASSEMBLE RELEVENT INPUT DATA
• CAPITAL AND OPERATING COSTS
• CONTAMINANT REMOVAL EFFICIENCIES OF EACH TECHNOLOGY
• INSTALLATION TIMES
• RELIABILITY OF TECHNOLOGIES
• PRIVATE BENEFITS (COST REDUCTIONS, ETC.)
ESTIMATE COSTS AND FINAL LOADINGS OF EACH BAT OPTION PER PLANT PER SECTOR
DETERMINATION OF LEAST-COST ABATEMENT COST FUNCTIONS
PROVIDE INPUT TO OTHER ACTIVITIES
BAT EVALUATION
EA ASSESSMENT

FIGURE 4-1

APPENDIX TO CHAPTER 4

An example of an abatement cost function showing the costs of reducing NO_x emissions from the stationary sources of that pollutant in the Sarnia, Oshawa-Toronto and Hamilton regions is shown in Table 4-1. This Table also shows the different types of cost estimates that can be generated from these analyses.

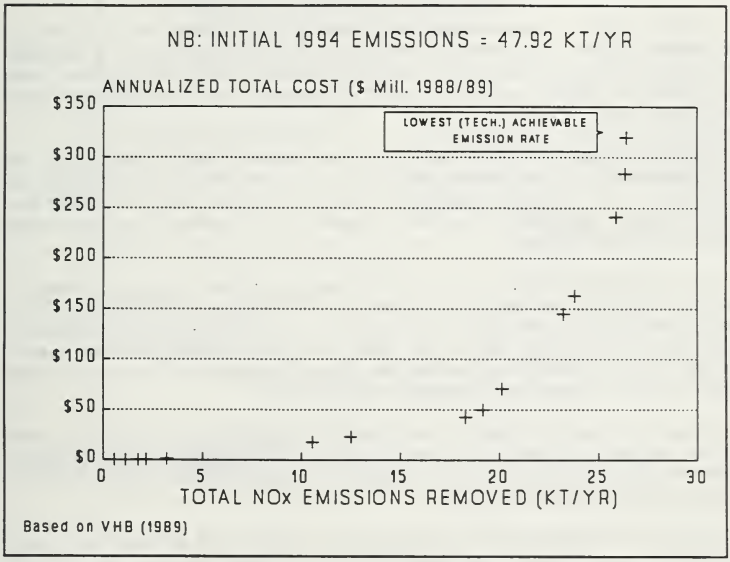
TABLE 4-1 LEAST-COST ABATEMENT COST FUNCTION FOR NO_x REDUCTIONS AT SELECTED STATIONARY SOURCES IN THE SARNIA, OSHAWA-TORONTO AND HAMILTON REGIONS

Reduction Level (%)	Incremental Cost ($/tonne)	Cumulative Reduction (tonnes)	Cumulative Cost ($)	Average Cumulative Cost ($/tonne)
1	$4	560	$2,088	$4
2	$20	1,120	$13,400	$12
4	$56	1,749	$48,500	$28
5	$501	2,154	$247,945	$115
7	$2,100	3,196	$1,870,528	$585
22	$2,100	10,556	$17,600,300	$1,700
26	$2,800	12,497	$23,019,300	$1,800
38	$3,400	18,289	$42,616,200	$2,300
40	$16,100	19,163	$49,996,500	$2,600
42	$23,300	20,127	$70,857,900	$3,500
49	$25,900	23,239	$145,003,300	$6,200
50	$37,600	23,800	$163,017,900	$6,800
54	$38,200	25,900	$241,119,300	$9,300
55	$247,800	26,357	$284,101,800	$10,800

Figure 4-2 shows a graph of the "Cumulative Reduction" of NO_x and the "Cumulative Cost" of NO_x reduction.

Each level of cumulative cost implies an increasing number of NO_x sources that have to implement controls in the study region. There are other combinations of NO_x abatement by various sources that should achieve each reduction level at a higher cumulative costs but no combinations that achieve any given reduction level at a lower cost.

FIGURE 4-2 GRAPHIC ABATEMENT COST FUNCTION SHOWING LEAST-COST NO_x REDUCTIONS FROM STATIONARY SOURCES IN THE SARNIA, OSHAWA-TORONTO AND HAMILTON REGIONS



5.0 PROCEDURES TO ASSESS ECONOMIC IMPACTS AND ACHIEVABILITY

5.1 Purpose

Procedures and information requirements for assessing the financial and economic consequences of the net costs of implementing proposed MISA limits regulations are set out in this Chapter.

Analytical procedures and financial indicators consistent with the economic principles discussed in Chapter 4.0 are identified, and relevant computational formulae are defined. Conventions are proposed for certain aspects of the analyses.

The process of economic achievability assessment of BAT options is summarized in Figure 5-1.

When available, threshold ranges can be used to judge how much incremental net cost of abatement might cause economic and financial disruptions to firms or to industrial sectors which are subject to the proposed MISA regulations. As should be shown, such threshold ranges are generally a matter of individual preference and value judgement rather than objective criteria.

It is, for example, widely accepted that social welfare would be increased if the value of additional goods and services produced by an investment exceeds the cost of producing them. The point at which the extra costs incurred begin to exceed the incremental benefits generated is the point beyond which investments actually cause reductions in economic welfare.

It is not possible, however, to say whether economic welfare has been increased if the rate of return for a polluting firm or industry is made to fall by 5% or 10% by abatement costs while, at the same time, returns to firms that produce environmental protection goods and services rise as the result of increased demand for their wares. Conclusions as to whether economic welfare has increased or decreased are somewhat less ambivalent if firms are forced into bankruptcy and plants close.

Moreover, as has been shown in the review of applications in Ontario and other jurisdictions, reported in Chapter 2, there is no standardized or widely accepted procedure or set of financial analyses that has been developed to evaluate "Economic Achievability" of regulatory requirements and their costs.

Analyses of financial impacts generally take the perspective of the firms and sectors which incur the costs of controls. Implications for a wider segment of society are indicated by effects on product prices. If bankruptcies and/or employment losses are forecast, wider effects on a community may be inferred.

Thus, assessments of the financial impacts of abatement costs on firms and industries do **not** provide clear and defensible criteria for setting unique effluent limits along the continuum that is technically possible.

ECONOMIC ACHIEVABILITY ASSESSMENT OF BAT OPTIONS

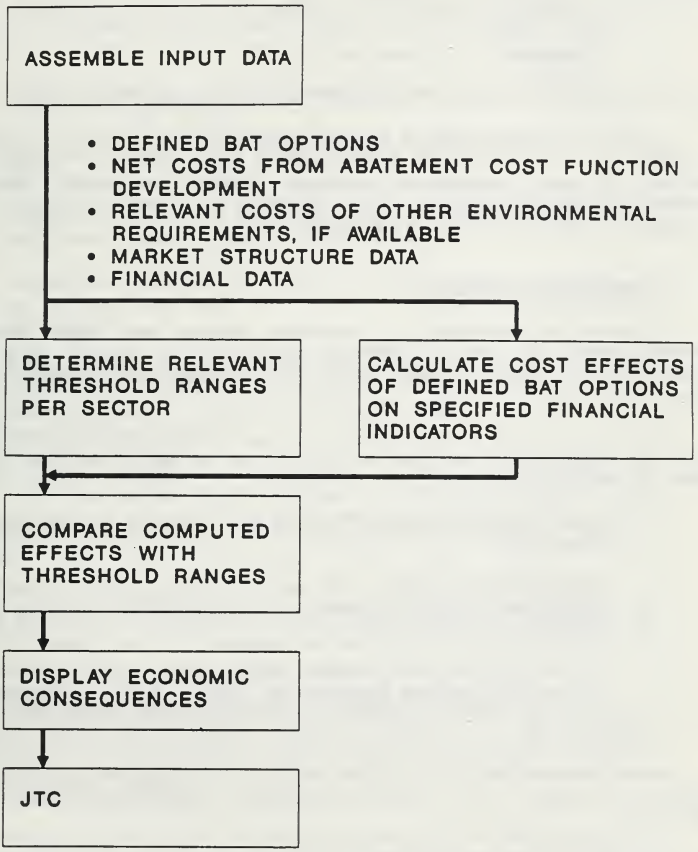

ASSEMBLE INPUT DATA
• DEFINED BAT OPTIONS
• NET COSTS FROM ABATEMENT COST FUNCTION DEVELOPMENT
• RELEVANT COSTS OF OTHER ENVIRONMENTAL REQUIREMENTS, IF AVAILABLE
• MARKET STRUCTURE DATA
• FINANCIAL DATA
DETERMINE RELEVANT THRESHOLD RANGES PER SECTOR
CALCULATE COST EFFECTS OF DEFINED BAT OPTIONS ON SPECIFIED FINANCIAL INDICATORS
COMPARE COMPUTED EFFECTS WITH THRESHOLD RANGES
DISPLAY ECONOMIC CONSEQUENCES
JTC

FIGURE 5-1

Therefore, the proposed analytical procedures, indicators and tests would yield results from which different interpretations and conclusions may be drawn, depending on the perspective of the reader. Consequently, reports on the analyses, which are to be carried out by subcommittees of each JTC, are to carefully display, and distinguish among:

- factual results,
- interpretations of the results, and
- conclusions

about "affordability" and "economic achievability" that may be drawn from the results.

All of the analytical procedures, indicators and tests proposed here may not have to be applied in each of the industrial sectors subject to MISA regulations. Moreover, as assessments are actually undertaken and experience is gained, some additional analytical procedures may present themselves as more appropriate for a particular sector. New analytical procedures may be included if all parties agree.

5.2 Assumptions and Conventions

A number of assumptions or conventions regarding time horizons, financing abatement expenses, the level of assessment, market structures faced by firms and industries and the regulatory scenarios that are to be evaluated are presented in this Section.

While net costs are to be estimated on a plant- or establishment-specific basis, analyses of economic effects may only be possible at the level of the firm or the industry for the following reasons:

1. Financial data are not widely available from public sources at the plant or product level.

2. Data gathering and analyses at the plant level during regulation development would impose excessive demands on both government and private sector resources.

3. Many of the financial and economic indicators facing a plant which is part of a vertically integrated, multi-plant firm would be the result of internal (ie. not "arms length") transactions and can not easily be verified by external reviewers.

Sectors should be given the opportunity to provide less aggregated financial data of relevance to the analyses. To the extent that such data are verifiable, they should be used as well.

Some of the establishments subject to the MISA Regulations are single-plant firms. Where financial data on these companies are in the public domain, economic analyses should, in fact, be a plant-specific assessment. Consolidated financial data for firms which are large and are vertically integrated, operate more than one plant or are Canadian

subsidiaries of foreign-owned parent companies, may not be representative of the plants subject to the regulation. This limitation should be noted when necessary.

Information on the **market structure of the various industrial sectors** subject to the MISA regulations and the product markets they serve should be analyzed to determine whether the relevant product markets are:

1. **Perfectly Competitive** - firms are price-takers and cannot easily pass on extra costs in higher prices,

2. **Oligopolistic** - there are few enough sellers to take account of each others behaviour,

3. **Monopolistic** - there is a single seller which can pass on extra costs as higher prices. Ontario Hydro is a legal monopoly,

4. **Monopsonistic** - firms are the only, or the major, customer of suppliers. It has sufficient market power to extract price reductions or other concessions from suppliers.

This information should indicate whether a firm should be able to pass all or part of its net incremental compliance costs onto its customers as higher prices or to suppliers by extracting price concessions. Otherwise, a firm should have to absorb the extra net costs as reductions in profits and returns.

Analyses should encompass a time horizon of ±10 years, or longer as appropriate. This time horizon should encompass a full business cycle, for most industries, for averaging historical economic and financial data as well as corresponding with the useful life of most abatement systems and equipment that might be installed in Ontario plants.

Due to the use of a ten-year horizon, or longer as appropriate, constant or real dollars should be used in all computations. This adjusts for effects of inflation on the dollar values at different times. The relevant conversion formula and deflators should be determined by each JTC.

Firms may finance their environmental protection requirements out of current revenues or they may borrow the funds. Various combinations of the two eligible financing approaches may be implemented. Because each financing approach would have different financial implications for a firm, analyses should be made assuming that one or the other financing option as is used.

For purposes of the analyses, it should be assumed that no financial assistance should be available from government, other than tax concessions such as sales tax exemptions and accelerated capital cost allowances. Such existing tax policies are only useful to firms that make a profit and actually pay income taxes.

Finally, there are likely to be many feasible BAT options or levels of abatement identified in cost functions that should be derived for a particular plant or industry. However, it may not be feasible to analyze the economic and financial impacts or "economic achievability" for all technically feasible levels of control. Consequently, the **analyses and tests defined in this Section should definitely be applied only to the net costs of BAT options and their net costs that are implied by a proposed MISA Effluent Limits Regulation for a particular sector.** The net costs of a proposed Regulation should be derived from plant-specific or industry-level cost functions.

5.3 Monitoring Phase Economic and Financial Indicators and Tests

This section describes procedures that were employed in reports relating to the incremental costs of monitoring and their implications for each MISA sector. Section 5.4 addresses procedures that are suggested for the assessment of economic achievability for the development of MISA Effluents Limits Regulations.

Three indicators or tests were used in the evaluations of the potential costs of the MISA monitoring regulations[18]:

a. **Return on investment or capital employed**[19] This is the rate of return the provides the incentive for owners and investors to remain in a particular enterprise rather than moving on to something else.

b. **Ratio of operating cost to after-tax profits.** This measure shows the short-run impact, on a firm's operation, of the regulatory requirement.

c. **Proportion of incremental capital costs to firm's historical capital expenditures.** This indicator shows the proportion of available capital that must be diverted to pollution control or augmented from other sources.

These analyses show how estimated monitoring costs would change each firm's performance measures if they had been incurred during the **worst year** of the past 3 to 7 years, during **average years** and during their **best years.** These adjusted performance measures were then compared with the **firm's** historical performance measures and those for the **industry** in which the regulated firm operates. No explicit threshold ranges were cited in the analyses of the MISA Monitoring Regulations although it was generally concluded that the potential costs would not cause undue financial disruptions to any of the regulated firms.

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[18] See for example Ontario Ministry of the Environment. **MISA -Monitoring Costs and Their Implications for Direct Dischargers in the Ontario Pulp and Paper Industry.** Policy and Planning Branch, August 1989.

[19] (After-tax Profits + Interest payments + Extraordinary Expenses)/(Total Assets - Current Liabilities). NB. operating costs were reduced by the corporate income tax rate.

It is clear that additional analytical procedures and tests should be applied to assess the implications of proposed limits regulations.

5.4 Abatement Phase Economic and Financial Indicators and Tests

Financial indicators and tests to be applied to proposed MISA Limits requirements should be directed at assessing the consequences for plants (if data are available), individual firms, industrial sectors and the provincial economy as a whole. Furthermore, assessments should be implemented to determine if there are disparities of effects between large and small (ie. 100 or fewer employees and/or less than $1 million per year in sales) businesses and between regions within the province.

To the extent possible, analyses should explicitly show distribution of various effects on the following segments and groups:

a. Owners or shareholders of firms,

b. Workers and employees,

c. Consumers,

d. Suppliers of goods and services for environmental protection.

Analytical tests and indicators are to be carried out for each industrial sector as needed. As noted, they should definitely be applied only for costs of specified levels of pollution abatement that are implied by a proposed MISA Effluent Limits Regulation.

The range of most commonly used financial indicators used in the United States by the USEPA for its economic achievability assessments are illustrated in Table 5-1. There are other financial indicators that can be used for analytical purposes, including the ones noted in Section 5.3 above, which were used by the Ministry in the MISA monitoring phase. In any sector, the list of analyses and tests may be expanded to reflect conditions in that sector.

Analyses to assess effects on firms are as follows:

1. Effects on owners.

   a. Show how the net incremental operating and capital costs would have changed before- and after-tax profits, dividends payments, debt and interest payments (assuming capital funds are borrowed), liquidity, cash flow and capital investment patterns in each of the past 10 years or longer as appropriate, for which historical performance data are available, assuming that the additional costs would be absorbed by reductions in profits.

Table 5-1

Overview of Financial Indicators Used in USEPA
Economic Achievability Assessments *

Category	Financial Indicator	Description
Profitability	ROA	Return On Assets (net income after taxes divided by total assets)
	EBIT/TA	Earnings Before Interest and Taxes divided by Total Assets
	EBIAT/TA	Earnings Before Interest but After Taxes divided by Total Assets
	ROS	Return on Sales
Solvency	CF/TD	Cash Flow (net income plus depreciation) divided by Total Debt
	TD/TA	Total Debt divided by Total Assets
	EBIT/TI	Interest Coverage (earnings before Interest and Taxes divided by Total Interest charges)
Liquidity	CA/CL	Current ratio (Current Assets - cash, marketable securities, accounts receivable - divided by Current Liabilities)
	QA/CL	Quick ratio (Quick Assets - cash, marketable securities, accounts receivable - divided by Current Liabilities)
	NWC/TA	Net Working Capital (current assets minus current liabilities) divided by Total Assets
Efficiency	S/TA	Sales divided by Total Assets

* Examples of the more commonly used financial indicators.
In any sector, the list of analyses and tests may be expanded.

Source: Peat Marwick (DRAFT)

b. Based on market structure, evaluate the ability of the firm to pass on incremental costs "up-stream" as higher product prices or "down-stream" as concessions from suppliers and/or workers.

c. Show how net incremental costs would have affected the suggested criteria in each of the past 10 years, or longer as appropriate.

d. Note effects in worst year of firms' operations over the study period.

e. Compare computed financial performance indicators that are altered by compliance costs with industry performance indicators over the study period.

f. Compare computed financial performance indicators with threshold ranges relevant to the sector.

2. Effects on employees.

a. Identify permanent and temporary increases or decreases in numbers of employees or hours worked.

b. Estimate potential increases or decreases in earnings to workers, if applicable.

Procedures and analyses to assess effects on industrial sectors are as follows:

1. Effects on owners.

a. Determine the effect on industry productivity where productivity is measured by sector norms, which could include:

$$\frac{\text{Total Value of shipments or production/Year}}{\text{Total number of employees during the period}}$$

with and without environmental requirements.

2. Determine effects on international competitiveness for the industry as measured by sector norms, which could include:

a. The difference between average cost of production (before and after incurring abatement costs) for producers in Ontario and foreign competitors, to the extent permitted by the available data.

b. Comparisons of competitive international prices, Canadian tariffs and domestic prices.

3. Determine effects on the Pollution Control Industry.

   a. Estimate composition and value of increased demand arising from regulations. Composition to include engineering and design, construction and installation and equipment.

   b. Determine extent to which environmental expenditures accrue to suppliers outside the province.

   c. Compute permanent and temporary employment arising from sector.

   d. Estimate increases in revenues and profits for this industry

In addition, assessments of the effects of incremental net costs on the provincial economy could include the following:

1. Effects on Consumers.

   a. Evaluate the extent to which each industry can pass costs through as price increases, and estimate the magnitude of such price increases.

2. Determine Net Provincial effect on employment, ie. the sum of the expected gains and losses in different sectors, including the environmental protection industry.

3. Assess the effects of the incremental costs on traditional macro-economic variables such as growth, investment, and price levels. Arrangements are being made to apply an econometric model to carry out such an assessment.

Effects on sub-provincial regions and small businesses.

1. Determine the number and location of small businesses in the regulated sector.

2. Evaluate whether the firm-level analyses reveal **disproportionate** consequences for small business regulated firms. Disproportionate means that small firms suffer more severe or adverse effects than larger firms in the same industry.

3. Identify single-plant communities whose plant is subject to the MISA Regulations. Clearly display the potential effects on plants located in the Northern and Eastern portions of the province.

5.5 Threshold Ranges

Financial reporting services and financial analysts for securities companies have many rules-of-thumb with which to determine whether a particular performance indicator bodes ill or well for the company in question. Moreover, the use of financial ratios to predict financial distress and business failure has received considerable attention by the U.S. E.P.A and by academic researchers in the U.S. However, there are no widely agreed upon threshold ranges for any of the performance indicators cited in this Section.

Consequently, the following criteria are suggested which can be used to judge whether a proposed BAT option should cause undue financial distress to the regulated firms, a particular industrial sector, to particular regions or to the provincial economy:

1. Do the net incremental costs of a proposed Limits Regulation push performance indicators in an adverse direction beyond the historical ranges recorded by a plant, firm or industry? If they do, the plant, firm or sector should likely be severely stressed.

2. Is the sale price or value of a plant or firm greater than the present value of the expected profits (over a 10 year planning horizon or longer as appropriate) after abatement is implemented?

   (NB. Information on the sale price of a company would be required for this criterion.)

3. Should capital requirements for pollution control leave a plant or firm with the minimum capital expenditure in any one year required to keep the plant operating with a necessary level of support, such as for repair and replacement, or for the capital components of R&D, product development, etc.?

   (NB. Verifiable estimates of the minimum amount of capital expenditure needed each year at specific plants are required.)

4. Do any plants or firms threaten closure? Is there evidence that such threats should be taken seriously? Examination of comparative standards in other jurisdictions could be made, and the likelihood that the plants may reopen under new ownership should be determined.

5. Is unemployment threatened in any single-industry towns or in Northern or Eastern communities with unemployment rates higher than the provincial average.

With these facts in hand, a clearer view of the economic and financial consequences of different BAT options can be presented.

6.0 SUMMARY AND CONCLUSIONS

This document represents the position of the MISA Issues Resolution Committee on Economic Achievability and provides the sectoral JTCs with the principles, procedures, and criteria to use as a framework for carrying out assessments of economic achievability for private sector entities and crown corporations subject to MISA abatement requirements. This should enable the JTCs to take into account sector-specific factors in their deliberations.

The contents of this document, with a few exceptions as noted, have been agreed-to by the members of the Issue Resolution Committee on Economic Achievability. Once endorsed, the procedures should provide a common framework for the JTCs in the development of the Limits Regulations.

Each JTC is constituted to provide expertise on the relevant sector. By agreement of the JTC or its appropriate working group, the assessment of economic achievability for any sector may deviate from the general framework set forth in this document. However, any such changes must be clearly documented and justified for the public review process.

Based on a thorough review of recent applications of the concept of economic achievability in the United States, Ontario, Canada, and other jurisdictions, it is evident that there is no clear or consistent definition of "EA". Nor is there a clear or consistent framework within which to apply the concept of economic achievability. Therefore, for Ontario and the MISA initiative, the procedure for the assessment of economic achievability should be defined and applied through the JTCs.

The single most important conclusion is that the assessment of economic achievability does not constitute a decision rule. Rather, economic achievability assessments are one of many inputs to the JTC decision-making process involved in the development of sector-specific Limits Regulations. These EA assessments provide decision-makers with the potential economic and financial consequences of different BAT options, including the distribution of these effects on sectors and groups in Ontario.

Economic achievability analyses therefore have four primary components:

1) cost estimation;
2) determination of cost-effectiveness (least-cost);
3) analysis of economic consequences; and
4) elucidation of the distribution of economic and financial consequences.

Cost estimates should be undertaken by JTC Working Groups. This exercise involves the collection of plant-level data and other information, including private benefits from pollution control. At least four BAT options should be analyzed in order to generate economic achievability assessments over a range of potential BAT options.

Cost effectiveness refers to the identification of the least cost means of achieving each BAT option.

Economic consequences should be determined based on assessments of the effects of estimated costs of abatement on selected financial performance indicators. The range of financial indicators should likely vary from one sector to another. The consequences of changes in these performance indicators can be assessed from a variety of perspectives, for example:

- change in profits (owners/shareholders)
- change in income and/or employment (employees)
- change in prices (consumers)
- change in sales (Ontario Environmental Protection Industry).

In addition, assessment of economic consequences should consider other factors, such as geographic issues and the difference of effects for small vs large businesses.

The distribution of these economic and financial consequences is integrated into the assessment procedure.

One issue remains on which the positions of various Issue Resolution Committee members differ. These differences are clearly articulated in this document and summarized below.

It is the position of some Issue Resolution Committee members that benefit-cost analyses should not be prepared as the basis for development of the Limits Regulations. Certain other Committee members, however, want consideration of public benefits in the JTCs in order to "ensure society benefits from the utilization of its scarce resources". Both positions are stated in Chapter 1 of this document.

The above principles and procedures are based on economic theories which provide a framework for the analyses and comparisons of alternative BAT options. The additional costs imposed by more stringent pollution control measures should increase production costs for the affected plants and products.

It is important that each JTC have a good understanding of the costs and consequences of potential BAT options in order to provide a sound recommendation for the option proposed as Best Available Technology, Economically Achievable.

GLOSSARY OF TERMS

ABATEMENT COST FUNCTION Shows the costs required to achieve different levels of final effluent loadings. Cost functions can be presented in tabular, graphical or equation form. In general, the greater the degree of abatement, the higher the costs incurred. Abatement cost functions are comprised of the lowest cost combination of abatement technologies required to achieve loading levels.

ABATEMENT TECHNOLOGY A technology or procedure to achieve contaminant removal or treatment. An abatement technology may be an in-plant process change and Best Management Practice (BMP), as well as an add-on, end-of-pipe treatment technology. One or more abatement technology may be combined as a Best Available Technology (BAT) option.

ANNUALIZED COST Computed by multiplying capital costs by an appropriate annualization factor based on an interest rate and the lifetime of the relevant abatement technologies. This annualized cost is then added to an annual O&M cost to show the total annualized cost.

BATEA Best Available Technology, Economically Achievable

BAT OPTION Combination of one or more abatement technology.

COST/BENEFIT ANALYSIS The calculation and comparison of the benefits and the costs of a program or project. Both public and private benefits and costs are explicitly identified and empirically estimated. As society's resources are limited, criteria or decision rules are necessary to determine how much should be spent on a given activity and to make informed trade-offs among different options. Benefit-cost analysis seeks to answer the question: do benefits exceed the costs of a given program or project.

BUSINESS CYCLE Regular oscillations in the level of business activity over a period of years.

COMPETITIVE MARKET A product market in which a large number of sellers and buyers participate. Buyers and sellers are price-takers and all participants have the same degree of information about the products and prices. Sellers cannot easily pass on extra costs in the form of higher prices.

CONSTANT (REAL) DOLLARS Dollar values in various years are adjusted to remove the effects of inflation. The adjusted values are expressed in common units of the dollar values of a specified base year.

COST-EFFECTIVENESS ANALYSIS The determination of the least-cost method or means of achieving a particular objective. Cost-effectiveness may also be expressed as the lowest cost per unit of objective achieved. It is based on the principle of "operational efficiency" and gives rise to operational criteria useful in evaluating environmental programs.

DIRECT DISCHARGER A plant or firm which discharges effluent directly into a waterbody, such as a stream or river. An **indirect discharger** is a plant or firm which discharges effluent into a municipal sewer system. Municipalities are considered to be indirect dischargers.

ECONOMICS The study of the science of allocating scarce resources to satisfy human wants.

ECONOMIC ACHIEVABILITY There is no single definition of this term. For some assessments, the USEPA has interpreted the concept to mean imposing only enough regulatory costs to force a minimum potential number of plant closures and job losses. In most assessments, the USEPA has reviewed a variety of financial measures in making judgements about Economic Achievability.

ECONOMIC ANALYSIS The application of economic principles and criteria to identify and evaluate the financial and economic consequences of a particular course of action.

FINANCIAL IMPACT ANALYSIS Assessment of changes in financial flows (eg. expenditures, revenues, profits) that result from a program or investment.

FIRM The owner or parent entity of a plant(s).

JOINT COSTS When abatement technologies or BAT options remove more than one pollutant at a time, there is no objective means of apportioning the costs of removal among each pollutant. A unique cost to the quantity of each pollutant removed cannot be assigned. Conventions or procedures can be used in such situations to derive appropriate cost functions.

JTC Joint Technical Committee, which is comprised of representatives from the Ministry of the Environment, Industry/Municipality, the MISA Advisory Committee, Environment Canada, and other provincial ministries. Each sector has its own JTC.

LAER Lowest (Technically) Achievable Emission Rate.

MAC MISA Advisory Committee.

MISA Municipal-Industrial Strategy for Abatement.

MODEL PLANT In the context of USEPA application, financial characteristics of a representative firm or plant are derived from aggregate data. The procedure was developed to overcome data deficiencies. This approach is feasible where appropriately homogeneous sector subcategories can be defined.

MONOPOLISTIC MARKET There is a single seller in a given product market. Ontario Hydro is an example of a legal monopoly. Monopolies can pass virtually all costs on as higher prices, but should experience reduced sales and possibly reduced profits subject to willingness of buyers to pay (ie. demand).

MONOPSONISTIC MARKET A situation where there is a single or major customer of many suppliers. It has sufficient market power to extract price reductions or other concessions from suppliers.

OLIGOPOLISTIC MARKET A few sellers in a market which are interdependent and must take account of each others behaviour. Prices tend to be higher than costs in this type of market than under perfect competition. Extra costs can be passed on by a single seller if all the competitors act in the same manner.

PLANT A production unit of a firm located at a single geographic location. A firm may operate more than one plant.

PLANT CAPACITY The full production capacity of a plant as referenced in company submissions. The plant capacity may differ from the initial design ("nameplate") capacity of a plant due to subsequent design modifications and add-ons.

PRESENT VALUES A procedure which permits comparison of costs and revenues which occur at different times. Because the value of a dollar generally decreases over time, future costs and revenues must be discounted. A present value is the current value of an expense or the value of a revenue incurred in the past or to be incurred in the future. Present values are calculated by multiplying annual O&M costs and capital expenses that are incurred over a relevant time horizon in the past or future by present value factors. Present values of future capital and O&M costs are then added to current expenditures.

PRIVATE BENEFITS Benefits accruing to an individual or firm as a result of its own economic decision. The private benefits of each BAT option can include reduced energy or materials inputs, saleable by-products, more cost-effective use of labour, enhanced production efficiencies, and improvements to product quality.

PRIVATE COSTS Costs borne by the individual or firm carrying out an economic activity.

PUBLIC BENEFITS Public and private benefits accruing (gains in welfare) which flow from a particular economic decision whether or not that party was involved in that decision. (Also, "external" benefits.) In practice, the social benefits from a project may be uncertain or accrue over an extended period of time. This makes the comparison of incremental benefits and costs problematic.

PUBLIC COSTS Public and private costs of some activity or output which are borne by society as a whole, and which need not be equal to the costs borne by the individual or firm carrying out that activity or producing that output. Pollution is an example of a social cost borne by third parties (society).

PUBLIC GOODS Goods and/or services which, because they cannot be withheld from one individual without withholding from all, must be supplied communally.

SECTOR In the context of MISA, a sector refers to a group of firms and their plants subject to MISA regulations. Roughly equivalent to an industry in an economic sense. Sectors and industries are identified by Standard Industrial Classification (SIC) numbers.

THRESHOLD RANGES A threshold "value" is a value of a parameter which is chosen to determine whether a particular performance indicator bodes ill or well for the company in question. Financial reporting services and financial analysts for securities companies use rule-of-thumb threshold values. For sectors, no single threshold value can be computed. Instead, threshold ranges can be determined whereby an informed assessment of the likelihood of undue economic and financial burden can be derived.

TIME HORIZON A period of time specified for review. For MISA economic achievability assessments, the time horizon is a maximum of 10 years in the past for the purpose of financial analyses, and 10 years (or longer as appropriate) into the future for the purpose of cost and market assessments.

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FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

LIMIT SETTING AND FORM OF LIMITS

ISSUE

To provide a procedure which makes use of BAT(EA) treatability data for the selected parameters in a sector or sub-sector to develop numerical limits for those parameters.

BACKGROUND

It is intended that Best Available Technology Economically Achievable [BAT(EA)] will be established for each sector taking into account the maximum application of economically achievable pollution control technologies and process changes. Numerical effluent limitations will be required as a quantitative means of assessing plant performance and compliance with BAT(EA) requirements. As advances in technologies enable better control, more stringent limits based upon BAT(EA) may be imposed upon revision of the Effluent Limits Regulation at the end of its initial five year cycle, and subsequently thereafter.

The steps essential for the calculation of the limits are illustrated in Figure 1.

In order to set limits the following information is required:

- a list of parameters which have been assessed by BAT(EA) treatability,
- BAT(EA) performance data,
- the form of the limit,
- effluent streams to be limited,
- methodology to calculate limits.

This Report outlines the recommended methodology for calculating limits.

Current Ministry Approach

Currently, the Ministry sets effluent requirements based on Policy 3 of the Ministry's "Water Management Goals, Policies, Objectives and Implementation Procedures of The Ministry of the Environment"[1].

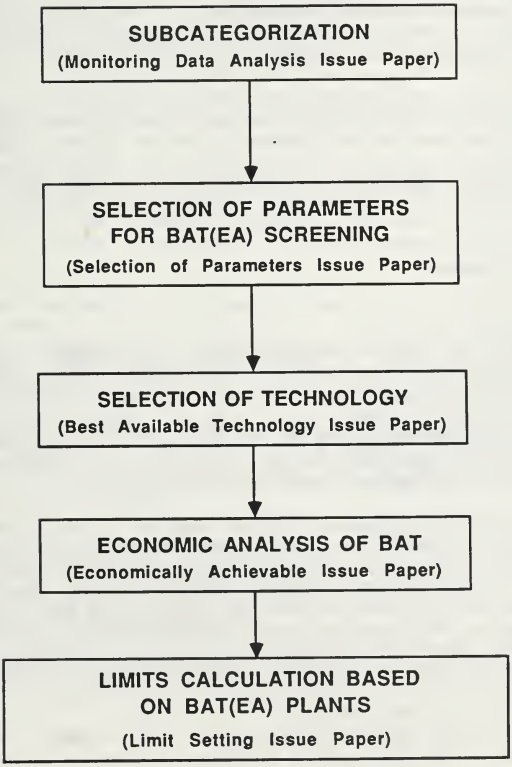
A summary of the procedure to establish effluent requirements is outlined as follows:

- Appropriate site-specific receiving water assessments are conducted to determine the effluent requirement based on the waste assimilative capacity of the receiver.

- The above-determined effluent requirements are compared to federal effluent regulations or provincial effluent guidelines.

Figure 1

THE PROCESS FOR DETERMINING LIMITS


SUBCATEGORIZATION
(Monitoring Data Analysis Issue Paper)
SELECTION OF PARAMETERS FOR BAT(EA) SCREENING
(Selection of Parameters Issue Paper)
SELECTION OF TECHNOLOGY
(Best Available Technology Issue Paper)
ECONOMIC ANALYSIS OF BAT
(Economically Achievable Issue Paper)
LIMITS CALCULATION BASED ON BAT(EA) PLANTS
(Limit Setting Issue Paper)

- The most stringent requirement is imposed.

This approach does not maintain consistency in deriving effluent requirements since it is based on a case-by-case study, which is dependent upon the impact on the receiver.

Currently, the Ministry of the Environment enforces effluent limits on dischargers as stated in Certificates of Approval granted under section 24 of the Ontario Water Resources Act[2].

Limits may be written in Certificates of Approval as maximum allowable concentrations and/or as maximum permissible loadings. When concentrations are used without loadings, a maximum allowable flow rate is specified. This serves the same function as specifying a maximum loading.

Where it has not been technically proven that the required level for a parameter can be attained consistently, effluent objectives are used. These objectives are goals or targets that dischargers must strive to meet. Failure to meet the objectives triggers a plan of action but does not constitute non-compliance. Long term averages, for example, average over a one year period, may be used to determine whether or not the objectives have been met.

U.S. EPA Approach

General

In the U.S., the Effluent Limitations Guidelines and Standards developed for the Organic Chemicals, Plastics and Synthetic Fibres (OCPSF) Point Source Category[3] represent the current thinking by the U.S. EPA. This was the latest set of effluent limitations promulgated for a point source category and continued to reflect an emphasis towards control of specific chemical substances, identified as toxic pollutants, rather than control of conventional pollutants. All EPA effluent limitations guidelines promulgated since 1982 have had toxic pollutant controls as their major focus.

The background work leading to the final limitations for the OCPSF point source category was the most extensive due to the diversity and complexity of the industry. The effluent limitations specified were concentration-based. These limits were translated into loading values in the site-specific National Pollution Discharge Elimination System (NPDES) permits according to historical flow data supplied by the plant. This approach is different from the one which specifies production-based loading limits (Refer to Table 1 in Appendix 1). The reason for the deviation in approach was the difficulty which the U.S. EPA experienced in finding a relationship between production rates and flow for the OCPSF category.

In most cases, EPA developed model treatment plants to establish production-based effluent flow rates. However, none of the effluent limitations guidelines regulations specifically limit flow. Dischargers are free to select any technology in order to achieve

compliance. In many cases, if the effluent limitations guidelines are based on flow reduction, the discharger would probably have to include flow reduction as part of the technology selected, particularly if high rate recycle was part of the model technology.

Form of the Limit

Where possible, the U.S. EPA effluent limitations guidelines and standards are expressed in terms of an allowable mass loading. These guidelines are then converted to individual permit limitations, based on production levels agreed upon during permit negotiations. EPA's NPDES permit regulations specify that mass effluent limitations should be included in NPDES permits wherever possible. This would be the case whether the effluent limitations guidelines were production-based or concentration-based. Appendix 1 contains a listing of the current forms of limit for the key sectors in the U.S.

In most cases, permits will specify a maximum allowable discharge for any given day and for a month.

Where the technology is concentration limited, a "normalized" flow (that is, a standard or model flow per unit of production, for example 1000 gallons per ton of production) for the particular operation is calculated. The normalized flow is then multiplied by the concentration the technology is capable of achieving, in order to derive a mass limitation.

EPA recognizes the suitability of concentration limits where a consistent production normalizing factor cannot be identified because there is a wide range of operations, product quality requirements, existing process configurations, or because there is difficulty in measuring production. When concentration limitations are imposed, EPA attempts to include permit provisions designed to ensure that dilution is not used to avoid treatment.

In some instances, concentration limitations are specified by the applicable national effluent limitations guidelines and standards, for example, for the metal finishing industry. Here, concentration limitations were selected because of the difficulty in establishing any reasonable basis for a normalized flow.

Limit Setting

The effluent limitations are derived by applying variability factors to long term average concentrations estimated for each parameter.

Once a pollutant is regulated for a point source category, it must also be limited in the permit issued to direct dischargers in that category. Hence, each discharger is required to comply with all the effluent limitations for all the pollutants regulated for that category.

Determination of the Long-Term Average (LTA)

In the OCPSF, for each pollutant at each plant, an estimated long-term average (LTA) effluent concentration was calculated. The method assigned non-detected values a relative weight in accordance with the frequency with which non-detected values for the pollutant were reported from all daily data for that particular pollutant. Where all plant-pollutant combinations were at or above the level of detection, the long-term average was the arithmetic mean of all values. If the frequency of non-detect values was not available for a particular pollutant, then the frequency for parameters in the same pollutant group was substituted.

The statistical analysis for determining LTAs was modified such that the values below the minimum analytical detection limit were assigned values of the minimum analytical detection limit. This resulted in somewhat conservative estimates since the assignment of a minimum level to non-detect values for calculating both variability factors and LTAs tended to produce slightly higher limits.

Determination of Variability Factors

In order to set a limit which is achievable by the BAT(EA) plant(s), some allowance for variability is included. Sources of variability include analytical and sampling uncertainty, manufacturing process variations, and treatment process fluctuations. Treatment process fluctuations result from normal changes in raw waste load, flow, and operational changes in the treatment system.

The variability factor is defined by the EPA as the ratio of a value at a selected extreme probability of occurrence (such as 95% or 99%) divided by the expected mean for a given data set.

In the U.S., the overall approach[3] to establishing effluent variability was as follows:

- long term records of daily effluent quality data were collected
- the data were edited to remove outliers
- an appropriate statistical model was fitted to the effluent quality distribution
- the daily maximum and monthly average variability factors were calculated from the fitted probability distribution as the ratio of the 99th percentile and the 95th percentile, respectively, to the expected mean.

Where variability factors for individual parameters could not be calculated due to insufficient data, and BAT for the pollutants was determined to be biological treatment, the variability factors from the pollutant group were transferred to the individual parameters within that group. Pollutant groups subjected to biological treatment were expected to exhibit comparable treatment variability based on a similarity of functional groups.

DISCUSSION

Scope

It is proposed that the process and statistical methodologies for setting effluent limits under MISA should follow the U.S. EPA approach. This statistical approach has withstood numerous court challenges[4] in the U.S.A.

Statistical procedures recommended for the limit setting process are outlined in the Final Report of the Issue Resolution Committee on Monitoring Data Analysis. The extensive data base for BAT(EA) plants obtained under the MISA Effluent Monitoring Regulations, or from other sources, would allow the calculation of long term averages and variabilities on which to base limits.

The following factors should be considered in the limit setting process:

- identification of BAT(EA) plant(s)
- form of limit
- parameters to be limited
- effluent streams to be limited
- statistical approach to limit setting
- methods used for limit setting.

An overview of the significance of each of the above factors is provided in the below.

Identification of BAT(EA) Plant(s)

Identifying BAT(EA) plants and obtaining the performance data are fundamental to developing the limits. The criteria recommended for identifying BAT(EA) plants is presented in the Final Report of the Issue Resolution Committee on Best Available Technology. Performance data for a single treatment technology or a combination of technologies may be provided as:

- List of parameters which can by treated by BAT(EA)
- Flow and concentration ranges over which BAT(EA) is valid
- Removal efficiency, where applicable, as a percentage of influent concentration or production
- Effluent data for BAT(EA) technology or a BAT(EA) plant

In principle, for a given sector or sub-sector, a single BAT(EA) plant is sufficient to provide information for calculating numerical limits. This BAT(EA) technology could be operational within or outside Ontario.

If BAT(EA) is not selected from Ontario, then BAT(EA) performance criteria, such as effluent concentrations or loadings, may be calculated by applying removal efficiency data from the BAT(EA) plant data to the effluent data from the Ontario plants.

Criteria for BAT selection should emphasize that the technologies proposed for BAT use the smallest quantity of water or maximize the recycle of water. Adopting the principle of water conservation, the daily concentration limit may not be required when there is a loading limit. It should be recognized that the effluent should be non-toxic. The U.S EPA recognizes the fact that a daily concentration limit may not be appropriate for industries that use water conservation measures[5]. In developing effluent guidelines limitations for the Iron & Steel and Petroleum point source categories, where water conservation measures were practised, limits were expressed as daily and monthly average loadings.

The Form of Limit

Options to be considered when selecting the form of limit include the type of limit and the time frame over which compliance with the limit will be measured. The various options for each sector or sub-sector are listed below.

The Type of Limit
- production-based loading
- loading
- concentration

The time basis for the limits
- daily maximum
- monthly average
- yearly average, etc.

Type of Limit
The type of limit influences the derivation of the numerical value since it defines the information to be included. Production-based loading limits require that a relationship between production and contaminant loading or flow be established. This ensures that the limits reflect plant operations and do not give unwarranted allowances for discharges solely based on plant size.

Concentration and loading limits, which are expressed as concentration or mass per unit time, respectively, would be based on similar sub-sectors to eliminate sources of diversity.

The choice of the type of limit will depend on the availability of data and correlation between variables such as flow, loading and production.

Loading limits and production-based loading limits may encourage the practice of water conservation. When dischargers conserve water in order to comply with the loading limits, concentration levels of contaminants may rise. Under these circumstances, a daily maximum concentration limit may not be set, provided that the original loading limit (prior to water conservation) remains unchanged, or is further reduced, and that the effluent is non-toxic. Under special circumstances, however, the JTC can recommend both loading limits and daily maximum concentration limits.

Time Basis for Limits

A time basis for the limit is required in order to calculate the variability factor.

Daily and monthly are the normally recommended control periods. The daily period is the shortest period over which routine sampling can be undertaken (for example, 24 hour composite sample). The daily control period takes into account unavoidable short term fluctuations. The monthly control period averages out the daily fluctuations, therefore enabling the setting of a more stringent monthly limit. Longer control period (for example, yearly) should not be considered due to the long time lag between determination of non-compliance and its actual occurrence.

Parameters to be Limited

The parameters which will be considered for limits for a sector or sub-sector are those that can be controlled by the defined BAT(EA). Under special circumstances, parameters which pose a significant threat to human health and the environment will also be limited regardless of BAT(EA). This "special circumstance" requirement is not designed to circumvent the normal limit setting process but is necessary in order to ensure that the environment is fully protected.

The MISA White Paper[6] states that limits would be set on a short list of easy-to-measure toxic and conventional parameters. On the basis that compliance with the requirements of the short list will correlate with the control of a longer list of contaminants of concern, the longer list need only be monitored on a less frequent basis in order to confirm the validity of the correlation.

Parameters that can be controlled by BAT(EA) will be divided into two groups for assessment of compliance:

- A primary group of parameters having monthly average limits based on measurements taken daily or taken one day per week. Each daily or weekly measurement would also have a daily maximum limit.

- A secondary group of parameters having a daily maximum limit based on a daily measurement taken once per quarter.

Parameters will be selected to the primary group on the basis of the following criteria:

- conventional and non-conventional parameters, and those parameters which represent the majority of toxic loading
- most frequently occurring parameters
- parameters to drive BAT(EA) or equivalent installation
- reasonable number of parameters to take into account administrative and economic factors.

Effluent Streams to be Limited

Since parameters are identified in relation to a sector or sub-sector and stream type, limits should be derived on the same basis. It is intended that limits will be imposed on all process, non-contact cooling water, stormwater and combined effluent streams. These effluent streams are being limited as they have the potential to impact the environment and the pollutant loading from these streams can be minimized with BAT(EA).

Statistical Approach to Limit Setting

The statistical approach to setting a limit for each parameter is based on the following steps:

- Calculation of the Long Term Average (LTA) from BAT(EA) plant(s)
- Determination of the Variability Factor (VF) from BAT(EA) plant(s)
- Calculation of the performance value as the product of LTA and VF.

The LTA and the VF for a given parameter would be calculated from the performance data of the BAT(EA) plant. If more than one BAT(EA) plant is identified, then the LTA and the VF values would be based on the average of the BAT(EA) plant values.

It was determined not to select the LTA and VF based on the best of BAT(EA) plant(s) but rather to use the average of the BAT(EA) plant(s) in order to ensure achievability with the limits and to allow for variations in plant operations. Selecting the

average LTAs and VFs of BAT(EA) plant(s) provides the opportunity for more BAT(EA) plants to meet the limits without major modifications of the treatment system or in-plant controls.

In order to set a limit which can be achieved by the BAT(EA) plant(s), allowance for variability should be included. Sources of variability include those that are associated with treatment processes, sampling and analytical methods and manufacturing processes.

The Long Term Average would be sufficient in itself as a limit value provided that the assessment for compliance also took place once on a "long term" basis such as 1 year.

To allow compliance assessment on a more frequent than "long term" basis such as daily, monthly and quarterly, a variability component must be built into the limit number to account for the impact of short term variability.

Methods Used for Limit Setting

Methods based on production, average loading and concentration may be used to calculate limits.

The mathematical steps in calculating a numerical limit using the three methods and the conditions under which each applies are shown in Appendix 2 - Table 1, and Figure 1, respectively.

A description of the methods and where they apply are summarized as follows

METHOD 1: Linear Method (production based)
This method allows the calculation of limits on the basis of flow and production.

The loading limit is expressed as a function of concentration and flow per unit production, where flow will be a numerical factor determined from BAT(EA) plant(s) and concentration will be the LTA determined from BAT(EA) plant(s).

This method is easy to apply. It also provides a clear direction for applying the numerical limits since it includes a straightforward calculation to be applied to maximum daily and average monthly limits.

The result is a production based limit which is expressed in terms of kg contaminant/kg product and therefore takes plant size into consideration. The fact that flow per unit production from the BAT(EA) plant(s) is used as a factor in the derivation imposes a restriction of effluent flow.

Use of this form of production based limit, however, implies that there is a direct relationship between production and contaminant loading, meaning that the limit imposed on a plant whose production exceeds that of another by a factor of 10, would be 10 times greater. Subsequently, the pertinence of this method will depend

on the whether or not a correlation exists between production and contaminant and loading, and if this relationship can be well represented in the final limit.

METHOD 2: Average Loading Method
This method does not require the availability of production data. The limit is expressed as a loading value which is derived from flow times concentration data of BAT(EA) plant(s).

It is, however advisable to consider production as a factor when testing for homogeneity of plants/processes. This will remove the effect of plant size as a source of significant variability within the data set to be analyzed. Variations due to water use and contaminant loading into the treatment system must also be accounted for in the definition of the homogeneous group.

METHOD 3: Average Concentration Method (concentration based)
This method may be applicable to industrial sectors where production and/or flow do not vary significantly. The limit, as a product of flow and concentration, may indirectly relate to production as long as there is a relationship between flow and production. If there is no relationship, the method only serves to promote greater water usage since plants with a greater effluent flow would be allowed a more lenient limit.

The limit is expressed as an absolute concentration value which is derived from the concentration data of BAT(EA) plant(s). The final loading limit may then be set on a plant-specific basis, taking into account the actual flow of each plant individually.

RECOMMENDATIONS

The Issue Resolution Committee on Limit Setting and Form of Limits recommends the following:

- Limits should be determined on a sector or sub-sector basis.

Type of Limit

- The type of limit should be:
    - Concentration
    - Loading
    - Production-based loading

  and the type of limit chosen should depend on the availability of data and the correlation between variables such as flow, loading and production.

- Where water conservation is practised, a daily maximum concentration limit may not be set, provided that the original loading limit (prior to water conservation) remains unchanged, or is further reduced, and that the effluent is non-toxic. Under special circumstances, however, the JTC can recommend both loading limits and daily maximum concentration limits.

Time Basis for Limits

- Limited parameters will be divided into:
    - A primary list of parameters having monthly average limits based on measurements taken daily or taken one day per week. Each daily or weekly measurement would also have a daily maximum limit.
    - A secondary list of parameters having a daily maximum limit based on a daily measurement taken once per quarter.

Parameters to be Limited

There was no general consensus on this sub-issue by the Issue Resolution Committee; hence, the various options are presented under *Unresolved Concerns*.

Effluent Streams to be Limited

- Limit setting should be applied to all process, combined, stormwater, and non-contact cooling water effluent streams.

Statistical Approach to Limit Setting

- For each parameter, limits should be based on the product of the long-term average (LTA) and the variability factor (VF) for the BAT(EA) plant.

- Where there is more than one BAT(EA) plant, the LTA and the VF should be based on the average of the LTAs and VFs, respectively, from all BAT(EA) plants.

There was no consensus at the Issue Resolution Committee for choosing the proper VFs; therefore options are presented under *Unresolved Concerns*.

Methods Used for Limit Setting

- The procedure for calculating VF and LTA values should follow one of the following methods:

Linear Method

The VF and LTA is calculated from the concentration data of the BAT(EA) plant(s). The product of VF, LTA, and the flow per unit production determined from the BAT(EA) plant(s) will be expressed as mass per unit of production

Average Loading Method

The product of VF and LTA is expressed as mass per unit time which is derived form the Long Term Average of loading and the variability factor of loading for the BAT(EA) plant(s)

Average Concentration Method

The product of VF and LTA is based on the absolute concentration value which is derived from LTA concentration data and the variability factor of the BAT(EA) plant(s).

UNRESOLVED CONCERNS *(Including Options)*

Parameters to be Limited

Alternative 1:

Limits should be set on parameters for which BAT(EA) treatment exists. Limits may also be set on other parameters which pose a significant threat to human health and the environment.

Alternative 2:

Limits should be set on only those parameters for which BAT(EA) treatment exists.

Statistical Approach to Limit Setting

Alternative 1:

In order to establish stringent limits, a statistical approach has been proposed. In this approach, the daily maximum and monthly average effluent limits will be calculated as the product of the long-term average (LTA) pollutant concentrations and the daily variability and monthly average variability factors (VFs), respectively. It is recommended that the daily VF be based on the 99th percentile concentration from the distribution of daily samples; and, that the monthly VF be based on the 95th percentile concentration from the distribution of monthly average samples.

As a result of this approach, for each limited parameter, four (4) events of non-compliance with the daily maximum limit in a one year period and one event of non-compliance with the monthly average limit in a 20 month period could occur without any negligent or abnormal operations at plants which have installed and are operating BAT(EA).

Alternative 2:

It has been estimated that use of the 99th percentile in determining the variability factor (VF) for daily maximum limits could result in 30-50 violations per year for a large facility that has installed BAT(EA) to comply with the intent of the MISA program; this is because large facilities may have a number of process effluent discharges, each of which may contain a significant number of parameters controlled by daily maximum limits. Therefore, those limits should be based on a reduced probability of non-compliance events.

It is proposed that the daily maximum limits be based on the 99.95th percentile (one non-compliance event per parameter in five years and two days), instead of the 99th percentile. This percentile will result in a limit value higher than that based on the 99th percentile, but will ensure there is no "statistical" non-compliance with the limits over the (five year) life of the regulation by a plant which has installed and is operating BAT(EA).
An analogous argument to that stated above could be used in choosing the variability factor for setting the monthly average limit, in order to ensure a similar level of "statistical" non-compliance.

Alternative 3:

In Alternative 1, the VF for the daily maximum limit (four non-compliance events per parameter per year) is overly stringent as compared to the VF for the monthly average limit (one non-compliance event per parameter in one year and eight months). In Alternative 2, VF for both the daily maximum and monthly average limits (one non-compliance event per parameter in five years and two days) is relatively lax as compared to the VF for the monthly average limit based on the 95th percentile (one non-compliance event per parameter in one year and eight months).

Some Issue Resolution Committee members felt that the limits should be sufficiently stringent, but at the same time, that the incidence of "statistical" non-compliance should be kept to a reasonable level. These members proposed that an acceptable compromise between the above two competing objectives could be reached using variability factors resulting in one non-compliance event in one year and eight months. Accordingly, the VF used for calculating the daily maximum limit should be based on the 99.8th percentile, and the VF used for calculating the monthly average limit should be based on the 95th percentile.

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Appendix 1

Table 1

FORM OF LIMITS - US EPA APPROACH

Industry	Form of Limit in Regulation	Form of Limit in Permit	Rationale
ORGANIC	concentration	mass limit	lack of product/ specific flow data
IRON & STEEL	mass limit per unit production	mass limit	means of controlling flow
PETROLEUM	mass limit per unit feedstock	mass limit + concentration if flow highly variable	means of controlling flow + consistent treatment
PULP & PAPER	mass limit per unit of production for continuous or concentration for non-continuous	mass limit or concentration limit	means of controlling flow consistent level of treatment
STEAM ELECTRIC	concentration	mass limit or concentration	flow normalized per unit production or no representative flow
MINING, METAL CASTING, INDUSTRIAL MINERALS,	concentration	concentration	no correlation between flow and production

Appendix 2
Table 1

For each of the three methods, descriptions of how these methods can be used to derive numerical limits which include allowance for variability, are presented.

METHOD 1: Linear Method (production based)

Step 1. Determine the LTA from BAT(EA) plant(s)

* Calculate a long term average concentration (LTA) for the parameter to be limited from BAT(EA) plant(s):

The value is calculated as a simple arithmetic average after applying the replacement rules given in the Final Report of the Issue Resolution Committee on Monitoring Data Analysis.

* Calculate the flow per unit production (Q/P), where Q and P are average values from the BAT(EA) plant(s)

* Determine the product of the LTA (conc) x Q/P to obtain a value in terms of kg contaminant/kg production.

Step 2. Calculate the variability factor

* Determine the variability factor (VF) of the LTA (conc) from all BAT(EA) plant(s). [As an example, VF could be set at the 95% level for a monthly average limit, and VF could be set at the 99% level for a daily maximum limit]

Step 3. Determine the basis for the final Limit

* The product of LTA (conc), the average variability factor (VF) and the average rate of flow per unit production (Q/P) will be the basis for the limit for that parameter.

* If a treatment facility receives more than one process, the limit will be based on the sum of the individual limits;
e.g. Limit = LTA.VF.flow/product (for process 1) + LTA.VF.flow/product (for process 2) +.....

METHOD 2: Average Loading Method

Step 1. Determine the LTA from BAT(EA) plant(s)

* Calculate the LTA for loadings generated from BAT(EA) plants.

* Statistical methods to produce loading estimates from the product of the distributions of concentrations and flows are outlined in the IRC Report on Monitoring data analysis.

Step 2. Calculate the variability factor

* Determine the average variability factor for loadings from all BAT(EA) plant(s). [As an example, VF could be set at the 95% level for a monthly average limit, and VF could be set at the 99% level for a daily maximum limit]

Step 3. Determine the basis for the final Limit

* The limit will be based on the product of the LTA of loading and the VF of the loading.

METHOD 3: Average Concentration Method (conc.based)

Step 1. Determine the LTA from BAT(EA) plant(s)

* Calculate a long term average concentration (LTA) for the parameter to be limited from BAT(EA) plant(s):

Step 2. Calculate the variability factor

* Determine the variability factor (VF) of the LTA (conc) from all BAT(EA) plant(s). [As an example, VF could be set at the 95% level for a monthly average limit, and VF could be set at the 99% level for a daily maximum limit]

Step 3. Determine the basis for the final Limit

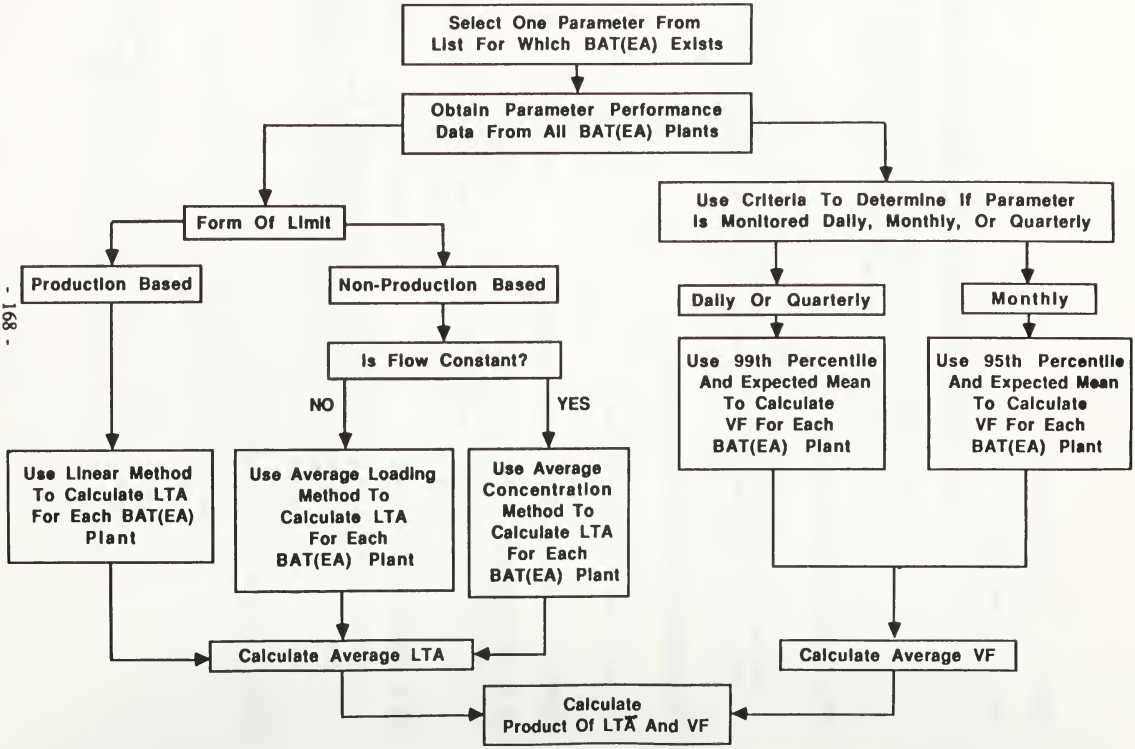
* The limit will be based on the product of the LTA of the concentration and the VF of the concentration.

* The final loading limit may be imposed on a site-specific basis as the product of the concentration limit times a representative flow value (for example, average peak flow over the previous year)

Appendix 2

Figure 1

PROCESS FOR LIMIT SETTING


Select One Parameter From List For Which BAT(EA) Exists
Obtain Parameter Performance Data From All BAT(EA) Plants
Form Of Limit
Production Based
Non-Production Based
Is Flow Constant?
NO
YES
Use Linear Method To Calculate LTA For Each BAT(EA) Plant
Use Average Loading Method To Calculate LTA For Each BAT(EA) Plant
Use Average Concentration Method To Calculate LTA For Each BAT(EA) Plant
Use Criteria To Determine If Parameter Is Monitored Daily, Monthly, Or Quarterly
Daily Or Quarterly
Monthly
Use 99th Percentile And Expected Mean To Calculate VF For Each BAT(EA) Plant
Use 95th Percentile And Expected Mean To Calculate VF For Each BAT(EA) Plant
Calculate Average LTA
Calculate Average VF
Calculate Product Of LTA And VF

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

NET LOADINGS

ISSUE

To delineate the conditions under which net loadings would be allowed/disallowed in the Effluent Limits Regulations.

BACKGROUND

In any examination of plant effluents, the contaminants found may be due in part, or in whole, to their original presence in the intake water. The concept of net loadings recognizes the fact that intake water is not pure and that contaminants may either pass unchanged through the plant or they may have their concentration levels altered by process sources or by treatment.

Theoretically, net loadings can be calculated by subtracting from the mass of a given contaminant discharged in a plant effluent stream over a given time period, the mass of that same contaminant which came directly from the intake water.

There is a potential for the use of net loadings in the following four areas:

- calculation of BAT(EA) plant performance for limit setting
- determining compliance with the regulatory limit where the intake contaminant is the cause of the exceedance
- reporting of effluent loading data to the public
- assessing compliance for non-contact cooling water

At issue is the determination of the need for the use of net rather than gross loading data for the purposes of the limits regulation.

Net loading data provides for the discharger lower discharge numbers but requires an extensive and costly effort to ensure the correctness of the net loading calculation. Some direct dischargers may in fact be removing certain intake parameters in their treatment systems and net loadings may provide recognition of this fact. However, beneficial environmental performance by dischargers may perhaps be better recognized through some other less complex means.

DISCUSSION

U.S. EPA Approach

Generally the U.S. EPA, except on rare occasions, does not allow the use of net loadings for compliance monitoring or in the reporting of effluent data because the EPA takes the view that a well operated treatment system should be able to achieve generally

applicable limitations despite the presence of contaminants in the intake water. The onus is placed heavily on the discharger to prove that intake contaminants make it difficult for the discharger to meet the effluent limitations.

Credits for pollutants in intake water are granted to the discharger if the following conditions apply[Ref.1]:

(1) The applicable national effluent limitation specifically provides that it shall be applied on a net basis.

(2) The discharger successfully demonstrates that the effluent limitation could be met in the absence of the intake contaminant if the treatment system is properly installed and operated.

Since there are no national effluent limits specified in the U.S. on a net basis, in reality only Condition (2) applies.

Where credits for intake contaminants are allowed, the following conditions apply:

a) For generic pollutants such as BOD or TSS, the discharger must demonstrate that the constituents in the effluent are substantially similar to the constituents in the intake water.

b) Credits are granted only to the amount necessary to meet the applicable limitation, to a maximum amount equal to the inlet contaminant concentration.

c) Credit shall be granted only if the discharger demonstrates that the intake water is drawn from the same body of water into which the discharge is made. This may be waived if no environmental degradation will result.

d) The discharge of raw water clarifier sludge generated from the treatment system is not included for credits.

Concept of Net Loadings

To scientifically support a net loading concept for process effluent streams, a mass balance approach would need to be applied to all influent and effluent streams. Any stream with potential to impact the mass balance would need to have sampling, flow measurement, analysis and QA/QC of comparable accuracy to effluent stream measurement.

The exact fractional contribution of the contaminant in the intake water making up the total discharge would need to be calculated. This would require detailed knowledge of the treatment removal and final destination of each contaminant of concern.

For complex sites the use of elaborate computer algorithms would be necessary to account for holdup times and treatment removals of the contaminants in each stream. Where process effluent streams are combined, calculations for contaminant removals would have to be integrated with those for untreated streams. Holdup times would also have to be integrated where streams are combined. Fluctuations in intake water quality would need to be incorporated in these calculations. Detailed knowledge, therefore, of holdup times in each plant would be required if the correct intake allowance is to be applied to the effluent contaminant level. Otherwise, it is possible to get negative loading numbers if a thorough mass balance is not applied.

For less complex sites, mass balance calculations used for determining the net loading contribution of the discharger may be less cumbersome.

BAT(EA) technology subjects all like contaminants to the same treatment regardless of source. It therefore allows no practical means of separately quantifying the impact of intake contaminants on the final performance data. The use of a net loading for limit setting would result in a fluctuating effluent limit that would vary with intake water quality.

In new BAT(EA) installations, consideration should be given to a sufficiently robust design to deal with the expected fluctuations in intake water contaminants, to the extent necessary to ensure that the effluent stream would be in compliance with effluent limits irrespective of intake water contaminant levels.

In terms of the impact of intake contaminants on compliance, dischargers may be concerned that on some occasions, despite proper BAT(EA) design, intake water contaminants may make it impossible to meet the regulatory effluent limits. Where such exceedances are demonstrated to be the direct result of intake contaminant levels, appropriate credit to the level of meeting the limit appears to be warranted.

For such cases, all streams which have the potential to impact the mass balance calculation used to determine the net loading, would require sampling, analysis, flow monitoring and QA/QC of comparable accuracy to the effluent streams. The mass balance calculation used to calculate the net loading is not applicable, however, if the nature of the contaminant of concern is different in the intake water compared to the effluent streams; for example, inert suspended solids in the intake water compared to biological suspended solids in the effluent. The net loading calculation can only be applied to the same specific contaminant under consideration to avoid the substitution of more toxic forms of the contaminant.

It has been proposed by some Issue Resolution Committee members that a discharger should be deemed to be in compliance upon demonstration that the plant would have met its limits if it were not for the elevated intake contaminant levels.

With respect to the reporting of data to the public, it has been proposed by these same IRC members that dischargers should not be responsible for removing pollutants that were already present in the intake water and should be given recognition for their removal

where this occurs. Further, it has been stated that net loadings provide a clearer picture to the public of a discharger's impact on the environment and would result in limits only on contaminants originating from the process operation.

To address concerns over intake contaminants with respect to the reporting of data, one group of IRC members suggested that consideration be given to publishing intake water data alongside effluent data, at the discharger's request, provided that the discharger follows the same MISA monitoring requirements as for process effluent streams. As a detailed mass balance is not being calculated in this case, a clear cost saving would result since the frequency of monitoring intake water need not be as rigorous. Sampling (flow proportional), analysis, QA/QC, and continuous flow monitoring would need to meet MISA standards to effectively generate a reliable database on intake water.

Another group of IRC members, on the other hand, proposed that if a discharger chooses to provide the Ministry with calculated net loading data for selected parameters, the Ministry should publish such values along with the normally reported discharge data. For this proposal, however, it is anticipated that a disproportionate amount of effort would be required, in terms of data handling and detailed mass balance verification, to ensure that the net loading calculations were correct and not misleading to the public. Moreover, the voluntary nature of the net loading data submission would make for a haphazard reporting system of little overall benefit to the public.

Generally, the mass balance calculations required to implement a net loading program would require large data handling systems and would require considerable resources to operate. Implementation could be costly, complex and time consuming with no overall benefit to the environment.

Net loadings should be considered in assessing compliance for non-contact cooling water streams. These streams typically have no contact with process streams or chemicals, have relatively short hold-up times at the plant site and are not subject to any form of treatment. Limits for these streams will be based on ensuring that no contaminants are added beyond those present in the intake water.

RECOMMENDATIONS

The following recommendations are put forward by the members of the Issue Resolution Committee on Net Loadings:

- Net loadings should not be used in the development of effluent limits.

  BAT(EA) technology subjects all like contaminants to the same treatment regardless of source. It therefore allows no practical means of separately quantifying the impact of intake contaminants on the final performance data. In addition, the water balance calculated on the net loading basis for each parameter would require an extensive and unduly costly program.

UNRESOLVED CONCERNS *(Including Options)*

Impact of Intake Contaminants on Compliance

Alternative 1:

Since the concept of net loadings would not be used in setting limits, it follows that no net loadings would be allowed in assessing compliance with the effluent limits.

Alternative 2:

Where a discharger is in non-compliance due to intake contaminants and demonstrates, to the satisfaction of the Regional Director, that in the absence of the intake contaminants the effluent limits would not have been exceeded, the discharger should be deemed to be in compliance.

Publishing Data

Alternative 1:

With respect to reporting of effluent loading data, the public should be provided with a clear picture of what each plant discharges into Ontario's waterways.

To the extent that reporting of typical levels of contaminants in intake water contributes to the better understanding of the environmental impact of a plant's discharge, such intake data should be reported alongside effluent data.

Consequently, for the publishing of data in Ministry reports, at the request of the discharger, consideration should be given to publishing intake water data along side effluent data. The intake water data would be subject to MISA sampling, analytical, QA/QC and flow measurement requirements.

Alternative 2:

In addition to the terms specified in Alternative 1, if a discharger provides net loading data, the Ministry should publish these data as well.

Applicability to Non-Contact Cooling Water

Alternative 1:

Net loadings should be used to assess compliance for non-contact cooling water to which no treatment chemicals have been added.

These streams typically have no contact with process streams or chemicals, have relatively short hold-up times at the plant site and are not subject to any form of treatment. Limits for these streams should be based on ensuring that no contaminants are added beyond those present in the intake water.

Non-contact cooling waters to which treatment chemicals have been added should be considered to be process effluents.

Alternative 2:

Net loadings should be used to assess compliance for non-contact cooling waters, but may not be allowed if treatment chemicals have been added.

REFERENCES

1) U.S. Environmental Protection Agency, Federal Register (40 CFR, section 122.45 (g)), July 1, 1988.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

TOXICITY

ISSUE

The objective in addressing this issue was to recommend and explain the application of aquatic toxicity testing in Effluent Limits Regulations. This would provide a consistent basis for the development of regulations for all sectors.

BACKGROUND

Aquatic toxicity testing is fundamental to MISA as a measure of effluent quality relevant to the environment. Toxicity testing by standard methods has been an integral part of the Ministry's program for the assessment of effluent quality since the trout test was formalized as a Ministry protocol (Craig et al., 1983). An acute lethality toxicity test protocol for Daphnia also has been developed by Poirier et al. (1988). Both these procedures are reliable methods for assessing the potential effects of effluents on aquatic life.

These procedures would be used for regulatory control of the toxicity of discharges. The Effluent Monitoring Regulations would provide a year of data on acute lethality to two important aquatic animals. This assessment of the status and variability of effluent toxicity would provide a baseline prior to the effluent limits regulations, and a portion of the information necessary for establishing BAT(EA)-based effluent limits regulations.

Since toxicity testing is a direct measure of the combined effects of effluent constituents, it provides an efficient mechanism for assessing the potential impacts of complex waste waters for regulatory purposes.

Throughout the following discussion, "effluents" refers to combined effluents, process effluents, once-through cooling waters and stormwaters as described in greater detail in the reports of other Issue Resolution Committees. There are, however, concerns regarding the inclusion of all stormwaters in this category by some Issue Resolution Committee members.

RECOMMENDATIONS

The following proposals are recommended by the Issue Resolution Committee on Toxicity for developing and incorporating toxicity requirements into the Effluent Limits Regulations. Rationale for each proposal is also provided.

It should be noted that the proposals presented are intended to come into effect after the regulation compliance date, that is, on the same date that dischargers must begin complying with the BAT(EA) limits. The Ministry has required toxicity testing in the past and shall continue to do so through the interim period until the regulation compliance date. Sector-specific requirements for interim testing should be recommended by the appropriate Joint Technical Committee.

- All direct dischargers should be required to monitor effluents for acute lethality to trout and to Daphnia magna according to Ministry protocols.

Toxicity testing is necessary because it is not always possible to predict the toxicity of a complex waste water by comparing a chemical characterization with objectives for aquatic protection. Since effluents are complex and variable mixtures, rather than simple solutions of single chemicals, there is also the possibility of unanticipated toxicants and toxicant interactions. Toxicity tests help address these uncertainties because they are integrated measures of the combined effects of all effluent constituents.

It is essential to take samples for toxicity and chemistry measurements at the same time to assist in evaluating potential causes of the toxicity.

A large percentage of effluent samples collected from discharges in Ontario are still lethal to trout and/or Daphnia. For some effluent samples, Daphnia are more sensitive than are trout whereas, for other effluents, the reverse is true. This makes acute lethality tests using both organisms an appropriate measure of current effluent quality. Since our objective is to conserve all aquatic life, both animals need to be protected and both are valuable toxicity test organisms. Because the composition of most complex effluents is constantly changing, the relative sensitivity of these two organisms to a given effluent also changes.

The value of identifying specific and proven toxicity test procedures is that the focus remains on the risk to aquatic life and on the large variations observed in current effluent quality rather than on the less relevant differences in sensitivity between species of fish or on smaller variations due to testing procedures.

Some Committee members expressed concerned about the availability of laboratory capacity, the resources to perform the required tests and the turn-around time of the proposed procedures.

Test protocols are also being developed by the federal department of the environment for use in new regulations. If these turn out to be compatible with Ministry test procedures, they may be considered equivalent. A discharger would then be able to comply with both federal and provincial requirements with the same test results.

- All effluent samples taken for the purpose of toxicity testing shall pass a compliance criteria for acute lethality to trout and to Daphnia magna; the criterion for both tests is 50% survival after exposure to 100% effluent for a specified period of time.

If water resources are to be managed, preserved and restored to permit the greatest number of uses, fish survival must be considered important because this level of stringency will protect water uses of considerable commercial, recreational and

aesthetic value. Trout were chosen as test organisms in part because trout populations take a very long time to adapt to alterations in their environment and many locations in Ontario are inhabited by rare sub-species which cannot be replaced.

Daphnia tests provide additional information about the potential impacts of effluents on the aquatic environment. It is important to protect other species as well as trout because all are components of complex aquatic communities. All forms of life also have an intrinsic value independent of human uses. It is essential, therefore, to control impacts on more than one type of aquatic animal.

Survival of 50% is chosen because it is clear-cut, and has a built-in margin that accommodates variability. The 50% survival criterion permits the "average" animal to survive.

The use of undiluted samples of effluent from the end-of-pipe is stringent. However this is offset by the use of acute lethality, the least stringent standard of toxicity.

Limits for toxicity are contingent on water use control so that toxicity criteria are not met simply by dilution. Some members of the Committee, while they agree to the basic criteria of 50% survival, disagree with the concept of the water conservation issue. The view of these members is that, in some instances, water conservation would lead to a decrease in "toxic loading", while at the same time, resulting in an increase in effluent toxicity. If water conservation leads to an improvement in the environment/ecosystem by decreasing the toxic loading, then the approach focusing on the toxicity of effluents should be replaced in favour of focusing on the impact on receiving waters. Other Committee members, on the other hand, are not convinced that there is a significant relationship between water use control and toxicity. The link between the two should be demonstrated with actual data, which were not available to the Committee. Water conservation requires changes in facility operations which do not necessarily imply an increase in effluent toxicity. An industry that has decreased the flow of its discharge from 200,000 cu m/day to 100,000 cu m/day, while laudable, is still a flow greater than the water used by most municipalities in the province. It is the view of these other members that both water use and toxicity need to be controlled independently.

It is important not to confuse concentration-based toxicity with the effects of environmental contamination caused by loading of persistent, bioaccumulative compounds. These substances do not always exert acute effects yet may have toxic impacts on the environment. Both types of effects are important and both need to be controlled.

The requirement for end-of-pipe testing means that samples can be taken directly from the effluent to determine compliance. This facilitates the implementation of uniform province-wide requirements. The testing of undiluted effluent samples is also consistent with the source control approach of MISA.

Similarly, modifying samples (for example, adjusting pH or hardness) makes the data difficult to interpret. Therefore, toxicity testing of unaltered samples is a regulatory requirement.

- Effluents whose samples pass, may be monitored with a single concentration test of the undiluted effluent.

Once the BAT(EA)-based regulation limit has been set for an effluent, it is not absolutely necessary to have full dilution series LC50 toxicity tests. One concentration along with a control exposure can determine compliance. It is acceptable to use single concentration tests (undiluted effluent and a control concentration) for monitoring effluents that are normally in compliance. Effluents that are not in compliance should be monitored with full dilution series LC50 toxicity tests because it is essential to know how much improvement is necessary to achieve compliance.

- Dischargers shall monitor the toxicity of their effluents for a minimum of one year. The Monitoring Regulation data would satisfy this requirement in most cases. For effluents that have passed during this period, testing would be continued at a frequency of four times per year. Until the one year non-acutely lethal condition is met, the discharger would be required to test monthly. For effluents that fail the BAT(EA)-based limits for either test, the discharger would be required to sample and test weekly for toxicity and to report on the probable causes without delay. Monthly monitoring frequency would resume if the samples pass for 3 consecutive weeks.

The physical-chemical and toxicological characteristics of many effluents vary with time to the extent that adequate sampling frequencies for completely assessing toxic effects are far beyond the available laboratory capacity or a realistic level of resources. As a practical minimum, effluents that are normally in compliance should be tested quarterly, effluents that are normally out of compliance should be tested weekly, and effluents that have failed within the past year should be tested monthly (see Figure 1).

In the event of a failure for either test, sampling frequency should increase to at least weekly and should not return to a monthly frequency unless the effluent toxicity tests pass three consecutive weeks.

Testing frequencies for intermittent discharges have to be handled as a special case for each sector. All such wastewaters should be demonstrated to meet the BAT(EA)-based limit before discharge to the environment.

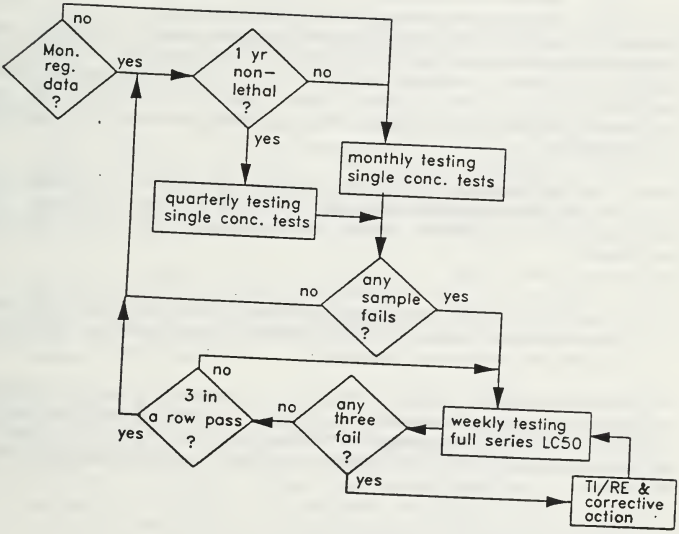


Figure 1. Required procedures and frequencies for toxicity testing.

- If an effluent fails for either or both test organisms on any three of the weekly samples, the Ministry would require the discharger to develop and perform a Toxicity Identification/ Reduction Evaluation.

The Ministry recognizes that it may be difficult in some cases to completely remove lethality from complex and variable effluents. If non-lethality is not achieved, then the discharger would be required to attain compliance with the toxicity test criteria through:

(1) implementation of an exhaustive in-plant evaluation to investigate the probable cause(s) of the remaining toxicity of their effluent;
(2) use of this information as a basis for a remedial action plan; and
(3) implementation of appropriate remedial measures.

During the Toxicity Identification/Reduction Evaluation period, dischargers would still be expected to maintain continued effluent toxicity testing at a frequency that would be determined by Ministry Regional staff on a site-specific basis, as well as compliance with all other regulatory limits, schedules, monitoring and other requirements. The toxicity evaluation would not afford protection from prosecution on toxicity limits.

Since Toxicity Identification/Reduction Evaluation procedures are evolving with experience, one single approach cannot be endorsed for all possible situations. The discharger would be required to develop a facility-specific study design, action plan and schedule.

- The Effluent Limits Regulations should be at least as stringent as toxicity requirements of federal regulations and should be compatible with existing international accords and agreements.

In establishing effluent limits for toxicity, it is essential to avoid unnecessary duplication of monitoring requirements. The Joint Technical Committees would be responsible to identify any potential conflicts for each of the sectors and the Ministry would undertake the task of negotiating with the other government agencies involved.

UNRESOLVED CONCERNS *(Including Options)*

Application of Toxicity Limits

Alternative 1:

Throughout the discussion, "effluents" referred to process waste streams, combined waste streams, once-through cooling water, and stormwater runoff.

Toxicity limits should be developed for all effluents.

Alternative 2:

Throughout the discussion, "effluents" referred to the final discharge of combined effluents, process effluents, and once-through cooling waters.

Effluents which were not monitored for toxicity under the Monitoring Regulation, should initially not be subject to toxicity limits. When enough data are collected, and the appropriateness of applying toxicity limits to that stream is evaluated, toxicity limits may apply.

Consequences of Failing Toxicity Tests

Alternative 1:

Enforcement actions, including prosecution, may result if any sample fails either the trout test criteria or the Daphnia magna test criteria at anytime, or if the discharger does not perform a Toxicity Identification/Reduction Evaluation as required.

Each failure is a non-compliance event and is eligible for prosecution. The toxicity criteria are never-to-be-exceeded because the requirement for nonlethal effluents is modest. If an effluent sample is toxic, even infrequently, there is potential for irreversible and significant harm to the aquatic environment. The criteria themselves are also modest since they will permit up to 50% mortalities in full strength effluent.

Never-to-be-exceeded criteria are necessary to control the environmental damage that can be caused by variability in effluents over time. Limits based on "average" LC50 would misrepresent this important property of discharges. For example, drastic shifts in effluent quality can and have resulted in fish kills.

Because the limits are clear cut, they can be implemented and administered by available staff. The conditions which could result in prosecution are clearly identified. Enforcement discretion will always be necessary to distinguish between a discharger exhibiting due diligence and one who has made little or no effort to attain and maintain compliance. The use of endless cycles of TI/REs is not considered due diligence and this mechanism for delaying remediation of toxic effluents should not be tolerated. Since the never-to-be-exceeded criterion is being applied to accidental, small volume spills, the same standard should also apply to continuous, large volume discharges.

Not controlling toxicity for more than one organism would ignore the fact that life varies in its sensitivity to toxic substances. If this were not so, pesticides would kill both the farmer and his crops during spraying. Similarly, for some effluent samples Daphnia are more sensitive than are trout whereas, for other effluents the reverse is true. Furthermore, effluents are complex changing mixtures. At one time, a given effluent might kill

more trout while at another time, the same effluent might kill more Daphnia. The toxicity to both animals should be monitored and controlled independently.

It would be illogical to monitor Daphnia and trout toxicity but only use the trout test for limits. What happens when an effluent is found that kills Daphnia but not trout? Such effluents exist and they are among the largest flows in the province. Any effluent could have this characteristic at one time or another. A government agency should not fail to act on the knowledge that discharges could affect such an important animal.

Alternative 2:

Enforcement actions may result if an effluent sample fails the trout toxicity test or if the discharger does not perform a Toxicity Evaluation study as required by failure of either the trout or the Daphnia magna test.

Because the limits are clear cut, they can be implemented and administered by available staff. Enforcement discretion will always be necessary to distinguish between a discharger exhibiting due diligence and one who has made little or no effort to attain and maintain compliance. A discharger who engaged in the performance a TI/RE, and who has taken all the reasonable steps to control effluent toxicity should be considered to be exercising due diligence and should not be subject to prosecution.

The following were comments submitted to U.S. EPA by the Water Pollution Control Federation (WPCF) in response to EPA's "Technical Support Document for Water Quality-based Toxics Control":

> *'The toxicity evaluation may be a long and difficult process. For the toxicity evaluation to determine a source or control strategy, the toxicity must be consistent or occur at a predictable frequency. The limits process should allow protection for a discharger during the Toxicity Evaluation process, since it must continue to discharge to solve a toxicity problem. This is particularly salient for a municipal plant which may have no knowledge or immediate control of the source of its toxicity. Some provision should be made for delaying punitive enforcement in situations in which a legitimate effort has been put forth in developing a data base and instituting controls, but the controls are subsequently found not to achieve the expected goals." (WPCF, 1990)*

The MISA Monitoring Regulation required toxicity testing of selected streams: *"The results of the toxicity testing will be used to:*

- *Establish a data base on the actual numerical median lethal concentrations (LC50) of each effluent discharge with a view to limit setting based on the rainbow trout test*

- *Assess the potential impact of complex, whole effluents on the environment.....*

.....Daphnia testing will not, however, be used initially for establishing whole effluent toxicity limits at the end-of-pipe. The Ministry is not considering the application of whole effluent, end-of-pipe limits based on Daphnia testing at this time."(MOE, 1988)

The Ministry's sentiments regarding the application of whole effluent, end-of-pipe Daphnia toxicity limits at this time as expressed in the Effluent Monitoring Regulations for the Petroleum Refining Sector have been, and will continue to be, supported.

Although numerous Daphnia test data will be generated by the Monitoring Regulations, none of the data has been analyzed or reviewed as to its suitability for use in the development of BAT(EA)-based toxicity limits. Some Committee members are not necessarily opposed to controlling toxicity to Daphnia, rather they are opposed to a legal end-of-pipe toxicity requirement at this time given the current understanding of the relationship between Daphnia toxicity and control technology.

Alternative 3:

Some Committee members stated that municipal direct discharges that fail the toxicity test criteria should not be subject to prosecution if they have an adequate sewer use control program which includes a Toxicity Evaluation. The position that each test failure is an event subject to prosecution would serve as a barrier to cooperation between provincial and municipal monitoring agencies. Prosecutions of municipal direct dischargers should only occur when they fail to implement and enforce a sewer use control program which includes a toxicity evaluation. The same Committee members are concerned that Toxicity Evaluations would be difficult for municipal direct dischargers and indicate that these dischargers cannot accept absolute liability to prosecution every time the test is failed when they have little control over those using their treatment plants. In addition, removal of toxicity due to chlorine and ammonia would be costly and may conflict with human health objectives. Enforcement actions against a municipal direct discharger for the failure of any sample is not acceptable and is seen as a threatening gesture in a program which must have full cooperation between the Province, Municipalities and Industry to be successful.

Sub-lethal and Chronic Toxicity Testing

Alternative 1:

It is recommended that trout and Daphnia magna sublethal and chronic toxicity monitoring for assessment be performed twice per year on discharges that are consistently non-acutely lethal.

While removal of acute lethality would reduce or eliminate the immediate impact on aquatic life, there may remain some sublethal or chronic impact of effluents that meet the BAT(EA) limits. An important component in the assessment of the potential for these impacts is to monitor effluents with laboratory chronic and sublethal tests. The methods to be used would be the 7-day *Ceriodaphnia* reproduction inhibition and survivability test and the 7-day fathead minnow growth inhibition test using protocols developed by the Federal/Provincial Inter-Governmental Aquatic Toxicity Group. Placing this requirement in the regulations would provide fairness across sectors since all would be required to perform the tests. Attempting to guarantee the interpretation of these results in advance of accepting the data would be unwise since no one can predict all possible interpretations nor does anyone have control of how this data would be used.

Alternative 2:

It is recommended that sublethal or chronic toxicity monitoring should be performed for assessment outside the Effluent Limits Regulation for those effluents which are consistently non-acutely lethal.

While removal of acute lethality would potentially reduce or eliminate the immediate impact on aquatic life, there may remain some sublethal or chronic impact of effluents that meet the BAT(EA) limit. An important component in the assessment of the potential for these impacts is to monitor effluents with laboratory chronic and sublethal tests. The results would be used in conjunction with receiving water characteristics to assist in determining if the effluents are contributing to an impact on the environment. The 7-day *Ceriodaphnia* and fathead minnow are useful methods. Those plants or sectors that consistently demonstrate that their effluents are non acutely lethal, should in conjunction with the Ministry, carry out a study to assess and interpret chronic/sublethal effects.

Sublethal or chronic toxicity monitoring should be performed outside of the regulation because there is currently no interpretive or guidance document to explain or interpret the meaning of the results. The results of the monitoring of sublethal and chronic toxicity should not be released without having key policies, and rigorous peer reviewed scientific support information in place. The public would be better served with such guidance documents in place, thus avoiding potential misinterpretation of the raw results.

A document such as the U.S. EPA's Technical Support Document for Water Quality-based Toxics Control and the Water Pollution Control Federation's comments on the U.S. EPA's document provides such needed guidance to regulating authorities, the regulated community and the public on the control of toxic discharges and could provide a basis for such a needed interpretive guidance document.

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APPENDIX

TOXICITY IDENTIFICATION/REDUCTION EVALUATIONS

BACKGROUND

The following will provide some assistance for performing Toxicity Identification/Reduction Evaluations (TI/REs) of effluents. TI/REs provide methods for determining the characteristics of toxicants in complex mixtures and the measures needed for compliance with wastewater discharge limits for acute lethal toxicity (MOE, 1984; 1986). It is not possible to provide a single procedure for universal application because each effluent is unique in terms of its composition and variability relating to the specific operations. Therefore, only guidelines can be provided for the design of a facility-specific TI/RE.

Facility Operation

When an effluent has been found to be toxic repeatedly, the first step is to investigate in-plant practices which may be the source of the problem (Fava et al., 1989). Areas to be examined are facility "housekeeping" (for example, spill control), treatment plant operation and the selection and use of process and treatment chemicals. If changes and improvements in these areas (for example, treatment plant optimization for removal of its design parameters) are insufficient to remove the toxicity of a final effluent, then a full Toxicity Identification Evaluation would be necessary.

Toxicity Identification Evaluation (TIE)

A TIE is an attempt to characterize, identify and confirm experimentally the physical-chemical characteristics of the effluent toxicity problem. Initially, it involves a series of chemical (effluent manipulations or treatments) and biological (toxicity) screening tests of the whole effluent that are used to isolate the causative toxic agents. Each effluent treatment (for example, aeration) is designed to remove or make biologically unavailable a specific class of toxicants (for example, "volatiles") in the effluent, without the need to identify each and every constituent of that class. Toxicity tests before and after the effluent treatments indicate their effectiveness for toxicity removal and may provide further information on the nature of the toxicants (Mount and Anderson-Carnahan, 1988a).

A single characterization test does not, by itself, provide proof that a certain chemical or class of chemicals is causing effluent toxicity. One must also perform further, more detailed tests on a number of different effluent samples to provide the "weight of evidence" necessary to identify and confirm effluent-toxicity relationships. The diagnostic value of a TIE can be limited if it does not include the full set of tests which are available (Mount and Anderson-Carnahan, 1988b; 1988c).

Source Identification or Treatability Studies?

Based on the results of a TIE, a discharger would then evaluate various treatment methods for removal of the toxicant from the final effluent or search (chemical-specific analysis for in-plant "tracking") for its upstream origin in the facility and control it at source.

If the identity of the toxicant is known, source identification may be more efficient and economical because it is usually easier to deal with smaller, concentrated side streams than with large, relatively dilute final effluents. However, the search for source streams becomes more difficult in complex facilities with variable production schedules and processes. It is also more difficult if the TIE has revealed a physical-chemical class of toxicants in the final effluent rather than a specific chemical.

Treatability studies on the final effluent can normally result in resolution of the toxicity problem but may require the construction or modification of a wastewater treatment unit.

Selection of the treatability or the source identification approach should be made on a site-specific basis and would involve consideration of: the results of the TIE, the ease of treating the final effluent, the number of possible source streams, the ability to modify facility operations and the variability in the causes of the toxicity.

Toxicity Reduction Methods

Remedial options for toxicity reduction include source reductions, modifications in waste treatment operations and/or additional treatment processes.

Source reductions are the practices and procedures to reduce or eliminate toxic loads from the most upstream end of a process to the point of influent to the treatment plant. It may involve the selection and use of process and treatment chemicals, process modifications, waste stream confluence, pretreatment of source streams, materials recovery or waste recycling.

The activated sludge process although designed and operated to optimize removal of BOD, can also remove, as a side benefit, many metals and nonpolar organics. However, modifications of waste treatment processes, beyond optimization for removal of design parameters, may still be required. Areas to be examined include hydraulic and mass loading of the facility, chemical feed rates, biological enhancement, source stream batching or segregation, effluent "polishing" and additional treatment processes.

Additional treatment technologies are often based on physical-chemical processes. These processes tend to be nonspecific; they remove a number of different chemicals simply because the substances share physical-chemical properties which make the treatment effective. For example, aeration removes volatile chemicals from solution; settling of solids removes hydrophobic chemicals from wastewater high in particulates because the

chemicals are, by nature, sorbed rather than dissolved; adjustment of pH alters the water solubility of organic acids and bases and can be used in conjunction with aeration and solids settling to maximize the effectiveness of chemical removal from wastewater. In this respect it is not always essential to know the identity of the toxicant to pursue a treatability approach based on the physical-chemical characteristics of the toxicants.

If more than one method is identified to reduce toxicity, then selection of the "best" method or combination of methods would be a site-specific decision that considers cost, performance and flexibility.

Follow-up and Confirmation

After the control method has been implemented, the final phase is to confirm that the toxicity limit has been attained and maintained. An effluent compliance biomonitoring program for trout and Daphnia (number and timing of samples) is part of the limits regulation.

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FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

FLOW MONITORING ACCURACY

ISSUE

To define the required accuracy and minimum accuracy verification frequency for effluent flow monitoring under the effluent limits regulation.

BACKGROUND

Under the Effluent Limits Regulations, limits on contaminants in effluent streams may be expressed in terms of total mass loadings of contaminants discharged to the environment. Mass loadings are determined by calculating the product of concentration and flow for an effluent stream.

Accurate mass loading data are important to assess compliance with the Effluent Limits Regulations and to provide toxic contaminant loadings to the environment.

The generation of concentration data under the Effluent Limits Regulations will be subject to strict sampling, analytical and QA/QC requirements to ensure that data gathered are accurate. As flow is a component in calculating mass loadings, flow accuracy specification will be necessary to ensure that flow data generated will be of comparable quality to the concentration data.

The objective of this Report is to provide recommendations on the level of accuracy of the flow measuring device, and minimum frequency of accuracy verification required for effluent flow monitoring under the Effluent Limits Regulations.

DISCUSSION

U.S. EPA Requirements

The U.S. EPA does not provide specific flow accuracy requirements for effluent streams. Despite providing effluent loading limitations for various industrial categories in the national regulations, there are no flow measurement requirements listed.

Direct dischargers in the U.S. are required to apply for discharge permits under the National Pollutant Discharge Elimination System (NPDES). Permits issued to each discharger contain a list of parameters to be monitored for assessment and for compliance. Limitations are usually expressed in mass loadings for each contaminant listed. Under the NPDES however, flow measuring accuracy requirements for all effluent discharge streams must meet an overall $\pm$ 10 % variation[Ref.1,3]. No distinction is made as to the effluent stream type.

Permit writers use discretion in deciding whether continuous flow monitoring is required. Toxicity, volume of discharge, and variability of effluent, are some of the factors used in the decision.

Dischargers are expected to calibrate flow devices on a regular basis with annual calibrations as a minimum. A maintenance program for each flow device is required for compliance with the NPDES[Ref.1].

Flow Measurement for the MISA Program

Effluent Monitoring Regulation Requirements

Flow monitoring requirements were specified for all effluent stream types during the Effluent Monitoring Regulations[Ref 2].

For process effluent streams an overall flow accuracy requirement of ± 7% was specified (± 5% for the primary device and ± 2% for the secondary device). A ± 5% accuracy requirement was chosen for the primary device since, as indicated by flow standard ISO 8363, this level of accuracy can be met by standard measuring devices. Secondary devices manufactured today will match or better the ± 2% accuracy requirement on the secondary flow device (at full scale reading). Continuous flow monitoring was also a requirement for process streams. A ± 15% accuracy allowance was made in the Monitoring Regulations for existing flow devices (devices in existence when the Regulation was promulgated) on process effluent streams. This was done to avoid unnecessary costs in requiring highly accurate flow measurement devices on streams that in all likelihood would be eliminated or modified for the Limits Regulations. In addition, two sectoral Monitoring Regulations (Mining and Industrial Minerals) noted specific process effluents where ± 20% flow accuracy was permitted.

The combined stream classification used in the Monitoring Regulations was applied to the many unsegregated streams that were mixed with non-contact cooling water before final discharge. This particular stream type arose to address concerns over the cost of installing new highly accurate flow devices on such streams which would eventually be segregated.

For all other effluent streams (except stormwater, which had no accuracy requirement under the monitoring regulations), including combined, batch, once-through cooling water, and waste disposal site effluent, there was a requirement to measure or estimate flow within an overall ± 20% accuracy.

Effluent Limits Regulation Requirements

Flow accuracy requirements for process effluent streams are proposed to continue to be measured at the ± 7% accuracy for the Effluent Limits Regulation. The primary device should meet the ± 5 % accuracy requirement while the secondary device should meet ± 2 % accuracy of the full scale reading. A revision of the accuracy requirements for the Effluent Limits Regulations is not required based on the Ministry's experience to date. Continuous flow monitoring of these streams should remain a requirement except for batch discharges. Process effluent streams under the Effluent Limits Regulations would be defined to include batch discharges.

Under the regulations, the ± 20% flow accuracy requirement for combined streams should be made more stringent, since segregation of non-contact cooling water and process effluent streams is expected for this particular stream type. Some Issue Resolution Commitee members proposed, therefore, that combined streams be monitored at the same accuracy requirement as for process effluent streams, that is, at an overall accuracy of ± 7%. Specifically, an accuracy of ± 5% for the primary device and ± 2% for the secondary device should be required. Best Professional Judgement (BPJ) may be used by the Joint Technical Committee (JTC) to permit the continued use of existing flow measurement devices on combined effluent streams which do not meet the accuracy of ± 5% on the primary device and ± 2% on the secondary device (full scale reading), provided that sufficient technical justification is provided.

Non-contact cooling water, stormwater (from stormwater control facilities) and waste disposal site effluent streams should continue to be monitored at the ± 20% flow accuracy requirements. Flow accuracy for these streams should continue to be specified at ± 20% since contamination from these streams (after the implementation of control measures) is expected to be minimal compared to process effluent streams.

A full calibration report (covering the expected flow range spaced at 20% intervals of this range) of all regulated process and combined effluent flow devices should be required upon installation of the flow device. Re-calibrations should be required on an annual basis thereafter and filed on site for future inspection. An ISO recommended five point flow calibration should be used on the secondary device.

A certification report showing that the primary flow device has been installed according to international standards would be acceptable in lieu of a calibration report. Re-certification of the primary device would be required on an annual basis thereafter and the report filed on site for future inspection. Calibration of flow devices would use scientifically established methods as detailed in recognized standards.

For primary flow devices which do not follow a recognized standard, and where problems such as variable or very large flows make conventional multipoint calibration impossible, recourse may be made to hydraulic modelling with a suitably scaled-down laboratory model. Verification of the model would be required on an annual basis thereafter and the results filed on site for future reference. A guideline should be available to provide details on information to be submitted in calibration, certification and modelling reports.

Calibration/certification requirements for all effluent streams, other than for process or combined streams, would be recommended by the Sector JTC.

To ensure the continued accuracy of flow measurement data on an on-going basis, it is proposed that, as a minimum, a monthly calibration check (zero and span) be conducted on the secondary device (from the sensing device to the readout device) for process and combined effluent flow measuring devices, where these exist. Re-certification/re-calibration should be required, however, if the primary flow device is altered or when effluent flows are outside the calibrated range reported in the last calibration.

Secondary flow measurement devices used on other regulated effluent streams, other than process or combined effluent streams, should have calibration checks performed quarterly to minimize the occurrence of significant drift from the original calibration at that actual flowrate. If the drift is greater than 2% a secondary flow device re-calibration would be required.

Results of monthly and quarterly secondary flow device accuracy checks would be stored on-site for future audit. Where these accuracy checks show non-compliance with the regulated accuracy requirements for process or combined effluent streams or where significant drift is shown for effluent streams other than process or combined streams, notification without delay is proposed.

A formal inspection and maintenance program should be followed for each flow device and maintenance records must be available for review during Ministry audits. The maintenance program should include as a minimum, monthly inspections of the flow device to assure normal operating conditions. Open channel primary devices, such as weirs and flumes, should be inspected to ensure that they are free of debris accumulation, encrustation and fouling. Closed pipe devices should be dismantled at least annually, cleaned and checked for correct dimensions.

Modifications or repairs to all flow devices should be fully documented and readily accessible for inspection.

RECOMMENDATIONS

The following recommendations are made by the Issue Resolution Committee on Flow Monitoring Accuracy:

- All process and combined effluent streams should be continuously monitored with an overall flow device accuracy of $\pm$ 7% (measured at full scale). The primary flow device component shall measure at an accuracy of $\pm$ 5% (full scale) while the secondary flow component shall measure at $\pm$ 2% (full scale).

- Non-contact cooling water, stormwater, and any other effluent streams, should be monitored with an overall accuracy of $\pm$ 20%.

- Calibration/certification reports would be required for all process and combined effluent stream flow measuring devices at the beginning of the regulation compliance period and annually thereafter.

- Re-calibration/re-certification would be required in cases where either the primary flow device on a process or combined effluent stream is altered or when flows are outside the calibrated range reported in the last calibration report.

- For non-contact cooling water, stormwater, and any other effluent streams, calibration/certification requirements would be recommended by the JTC.

- Monthly calibration checks would be required for all secondary devices on regulated process and combined effluent streams.

- Quarterly calibration checks would be required for all secondary devices on other effluent stream types.

- In cases where non-compliance with the accuracy requirements of the regulation has occurred for secondary devices on process or combined effluent streams, or where significant drift is shown on the secondary device for effluent streams other than process or combined streams, the Ministry should be notified without delay.

- As a minimum, monthly inspections should be required for all regulated process and combined effluent primary devices to ensure proper operation. For other streams, an appropriate inspection frequency should be recommended by the JTC.

- The results of monthly and quarterly calibration checks as well as maintenance and inspection records are to be kept on site for future Ministry audits.

UNRESOLVED CONCERNS *(Including Options)*

Accuracy of Measuring Device

Alternative 1:

Best Professional Judgement (BPJ) may be used by the JTC to permit the continued use of existing flow measurement devices on combined effluent streams which do not meet the accuracy of $\pm$ 5% on the primary device and $\pm$ 2% on the secondary device, given that full technical justification is provided.

Alternative 2:

BPJ may be used by the JTC to permit the continued use of existing flow measurement devices or estimation methods on process and combined effluent streams, given that sufficient technical justification is provided.

REFERENCES

1) U.S. Environmental Protection Agency, "NPDES Compliance Inspection Manual (Draft)", February 1987.

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3) U.S. Environmental Protection Agency, "NPDES Compliance Flow Measurement Manual", September 1981.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

COMPLIANCE

ISSUE

To establish compliance rules under the Effluent Limits Regulation:

- *To make compliance clear, consistent, easily assessable and uniformly enforceable.*

- *To define, where required, the actions and timing for achieving compliance.*

BACKGROUND

Scope

The MISA program under the Effluent Limits Regulation will establish enforceable limits on the discharge of contaminants which are not adequately addressed under the current regulatory framework.

Currently, control of discharges in Ontario has been plagued with problems because of the difficulty of enforcing existing limits. Problems have included:

- The use of unenforceable guidelines,
- Inconsistent application of limits across the province,
- Lack of rationale for derivation of limits,
- Lack of defined and uniform sampling and analytical procedures,
- Lack of flow accuracy requirements,
- Lack of consistent policy for averaging procedures and time of application of limits.

Under the above conditions, the ability enforce control of discharges is severely limited.

It is important that the current problems be addressed and rectified under the limits regulations. Monitoring regulations that are already in force address some of the problems. For example, requirements are explicitly stated for sampling methods, analytical procedures, accuracy of flow measurement, quality control, and data submission. The limits regulation will retain these aspects and address the current shortcomings as well.

U.S. EPA Approach

The U.S. EPA has a reporting regulation under which permitting agencies (States or EPA regions) are required to report occurrences of non-compliance to the EPA head office in a quarterly non-compliance report (QNCR). Reportable violations include multiple exceedances of limits by a certain factor, and delays in construction or submission of data over a specified time allowance.

EPA considers any exceedance of a limit value as a violation[1], however only a subset of the exceedances are reportable. A further breakdown is made of dischargers with serious violations or appearing on more than one QNCR for the same violation. These are considered to be instances of significant non-compliance that are not being resolved in a timely and appropriate manner. These then receive the focus of the EPA administrator. The purpose of the reporting regulation is to provide a tool for the EPA to focus enforcement activities.

The key components of the U.S. EPA enforcement program include the following:

1. Enforcement Management System;
   - ensures enforcement done in a logical consistent manner
   - avoids actions considered to be harassment or arbitrary and capricious
   - frequency of inspections and enforcement follow-up activities are dependent on geography, compliance history and time since last inspection
2. Permit Compliance System;
   - track compliance information and identify violations. There is no automated tracking of compliance with the daily maximum effluent limitations.
   - provides standardized mechanism to report and record
3. Enforcement Priorities;
   - identify significant non-compliance (SNC) via quarterly non-compliance reports
4. Established procedures for inspection activities.

DISCUSSION

Legislative Authority

The Ministry position on compliance is derived from existing legislation and from current policies for abatement and enforcement. Based on these, the following definitions can be established.

Compliance: A state achieved by adhering to the legislative and regulatory requirements of the Ministry of Environment.

Violation: A contravention of any Act or regulation administered by the Ministry of Environment.

Abatement: Measures to bring about compliance including the prevention, reduction and elimination of pollution.

Monitoring and limits regulations will come into force under Sect. 136 of the Environmental Protection Act. The Act also provides for penalties for offenses.

Compliance with the limits regulation will require satisfying its requirements for:

- Meeting limits on the concentration or loading of contaminants and on the toxicity of effluents
- Following prescribed sampling and analytical protocols
- Reporting analytical and toxicity data
- Keeping records
- Notifying the regulatory agency of any changes that impact on the dischargers ability to fulfil regulation requirements
- Reporting events, such as by-passes
- Development and implementation of plans, for example, for stormwater control
- Maintaining construction schedules for wastewater treatment facilities

Compliance Rules

The limits regulation will contain uniform limits for each sector or sub-sector. These limits will ensure equitable treatment for all dischargers.

Using BAT(EA) performance data, sector or sub-sector and pipe-specific limits will be set out in the limits regulation.

The development of a comprehensive Effluent Limits Regulation which contains plant and/or pipe specific limits will have the following advantages:

1. The limits will not be subject to appeals.

2. A single document will include all BAT(EA) limits. This will make the requirements clear and simple to enforce.

For each requirement in the regulation, there will be a compliance rule to ensure that all actions required of the discharger are understood. Examples are given as follows:

- Concentration or load and toxicity limits, must not be exceeded. The time period over which the limits apply (i.e. daily, monthly average etc.) will be specified in the regulation.

- For monitoring requirements, the sampling protocol, analytical methods and flow measurement accuracy will be specified.

- For submission of reports or data, the contents, timing, format, and recipient will be specified.

- For reports or plans that are subjective in nature, a guideline document may be needed.

- Details of procedural requirements may be included in the regulation or in guidelines.

- For record keeping requirements, the retention period and the specific information to be retained will be specified.

The assessment of compliance by Ministry staff will be achieved by different means. Examples are given below:

- For limit exceedances, compliance is assessed by comparison of the load or concentration value with the regulatory limit.

- Reporting requirements are easily assessed on the deadline dates by checking the timeliness and completeness of data or report submissions.

- Some reports or plans, with the details of contents laid out in guidance documents, will require technical review to establish compliance.

- Procedural and record keeping requirements can only be assessed by audit inspections.

The regulation will repeat the self monitoring requirements currently in the monitoring regulations, modified and augmented by any new requirements needed for the limits regulations.

Compliance Enforcement

The Ministry has Abatement and Enforcement Policies which are currently being revised into a single Compliance Policy. This policy will set out the procedures and control instruments to be used to bring about compliance.

At any stage of the abatement process, the Ministry may consider prosecution:
- as a means of addressing violations,
- as a first step to achieving abatement,
- to enforce its requirements.

The Ministry uses a staged response to violations within the framework of the compliance policy. For all violations the following principles apply:

1. All violations are offenses for which the discharger is strictly liable.

2. All violations by the discharger require Ministry action, and discharger explanation.

3. Ministry actions would be appropriate to the circumstances of the violation, that is, frequency and severity. The Ministry would develop a guidance document to advise abatement staff on appropriate responses.

4. All violations, Ministry actions and decisions, and discharger responses should be documented.

In this framework, there would be no designation of violations as "significant".

Compliance Assessment

Bubble

The "bubble concept" refers to an overall plant limit, as opposed to pipe-specific limits on each outfall. It allows the discharger the flexibility of allocating effluent loadings among its outfalls in the most cost-effective manner commensurate with the impact on the environment.

Under the bubble concept, dischargers would have the option of reallocating contaminant loadings among outfalls, provided the overall site limit is met.

In the interest of providing dischargers with the flexibility required for minimizing costs, the JTC should address the following constraints:

- Each outfall must have a specific discharge limit. Plant limits should not be based on a floating reallocation bubble.

- The bubble concept may be rejected if it results in impairment of water quality.

- Allocation of effluent loadings among several outfalls should involve the same pollutants, with no increase in overall site loading.

- Transfer of contaminant limits should involve only like streams with no masking allowed.

- Despite any transfer of contaminant limits, concentration of the contaminant in each outfall must be non-toxic as per the Toxicity Issue Resolution Committee Report.

The above constraints may be accommodated by providing the Industry a one-time allowance to re-allocate limits among effluent streams from the same plant. This provision will be incorporated into the regulation, prior to the BAT(EA) limits coming into force.

Monitoring

The variability factors (VF) are key in establishing the daily and monthly limits and are directly linked to the number of samples to be taken. A trade-off must be made between cost and accuracy or acceptable error.

For example the required number of samples can be estimated, if certain assumptions are made. If a relative error of 25% in the estimate of the mean monthly concentration or load is acceptable at the 95% significance level, and the coefficient of variation is assumed to vary from high, medium and low of .7, .5, and .25 respectively, then the required number of samples can be calculated. This results in a sample sizes of 30, 15 and 4, or roughly daily, three times weekly and weekly for monthly monitoring requirements (4). A relative error of 25% is not an unreasonable assumption since the plants under limits would be operating with BAT(EA) and will be expected to comply with strict QA/QC for sampling and analysis.

The Ministry has established uniform sampling frequencies to simplify requirements for compliance.

Monitoring for compliance with the limits regulation would include:

- A primary list of parameters having monthly average limits based on measurements taken daily or taken one day per week. Each daily or weekly measurement would also have a daily maximum limit.
- A secondary list of parameters having a daily maximum limit based on a daily measurement taken once per quarter.

The assignment of parameters to the three frequencies will be based on a balance between the need to demonstrate ongoing high level of BAT(EA) treatment for all treatable parameters and the costs associated with monitoring at each frequency.

Parameters chosen for daily monitoring will be easy-to-measure indicators to ensure that daily process and treatment operations are being controlled and that the BAT(EA) treatment is being operated at its maximum removal efficiency.

Parameters for weekly monitoring are expected to be those key toxic substances and non-conventional parameters. Parameters capable of serving as surrogates will be the preferred choices in that their response to BAT(EA) treatment can also serve as a model for the treatment response of a larger number of compounds of the same chemical group.

Quarterly monitoring will be required for the remaining BAT(EA)-treatable parameters for which limits are set to ensure that their removal continues to correlate with the removal of the higher frequency monitored parameters.

Monthly averages based on total operating days per calender month or based on weekly sampling will be calculated as the simple arithmetic mean using the replacement rules specified in the Issue Resolution Committee Report on Monitoring Data Analysis.

Sampling requirements for compliance assessment will be defined in the Limits Regulation and will be consistent with those required under the Monitoring Regulations.

To assess compliance with the daily maximum limit, individual values (daily, weekly, or quarterly) will be compared against the regulatory daily maximum limit. The regulatory daily maximum limit is calculated using the variability factor for one day, VF(daily).

To assess compliance with the monthly average limit based on daily measurements, the average of the daily samples taken on all the operating days during the calender month will be compared against the regulatory monthly average limit. The regulatory monthly average limit is calculated using the variability factor for one month (VF30) based on P_{95} *(or the percentile as finally defined under the issue of Limit Setting and Form of Limits).*

To assess compliance with the monthly average limit based on weekly measurements, the average of the weekly samples will be compared against the regulatory monthly average limit. The regulatory monthly average limit is calculated using the variability factor for one month (VF4).

The proposed limits under the MISA program will be based on the performance data from BAT(EA) plants in Ontario gathered over the one year regulatory monitoring period for a given sector or sub-sector. Where MISA BAT(EA) data does not exist, use can be made of other databases provided they meet the MISA data quality criteria outlined in the Final Report of the Issue Resolution Committee on Monitoring Data Analysis.

Since the performance data from BAT(EA) plants reflect a long term statistical distribution of values, a decision has to be made on how a single value limit would be derived from the distribution.

It is recognized that implementation of limits based upon "VF(daily) equal to the 99th percentile concentration from the distribution of daily samples" and "VF(30) equal to the 95th percentile concentration from the distributon of monthly average samples" implies a statistically predicted non-compliance with the daily maximum limit of up to 4 times per year per parameter (once per 100 days) and up to 5 times per 100 months per parameter (once in 20 months) for non-compliance with the monthly average limit. These exceedances could occur without negligent or abnormal operations in plants which have installed and are operating BAT(EA).

Use of percentile values higher than 99% and 95% would reduce the "statistical" non-compliance frequency but will result in higher limit values. Thus, a 99.95 percentile-based limit would reduce the probability of "statistical" non-compliance to one event per parameter in 5 years, but the limit value could be significantly higher than that based on the 99th percentile.

Compliance Timing

To comply with the effluent limits it will be necessary for most plants under the Effluent Limits Regulation to construct new or modified treatment works. These treatment works require approval under section 24 of the Ontario Water Resources Act, prior to construction. In order to expedite the implementation of the MISA Effluent Limits Regulations, the approvals process should be modified to include a "fast track" approach for treatment works related to the construction and operation of BAT(EA).

Upon receiving a complete application for approval from Industry, the Ministry would screen the application within 10 days. A decision would be made as to whether the application can be processed according to the "fast track" approach, or whether a detailed review which is normally conducted is required.

Applications processed under the "fast track" would be completed within 90 days of the acknowledged receipt of a complete application for approval. Requirements of a complete application will be included in the Effluent Limits Regulation (see Table 1). In the event that the discharger fails to submit a complete application, the discharger should resubmit the application as expeditiously as possible. Under these circumstances, the discharger would not be given additional time for the construction of treatment works. On the other hand, if the Ministry fails to respond to a complete application within 90 days, the treatment works should be deemed approved.

A detailed review of the application may be required under the following circumstances:

- BAT(EA) facilities are required to meet additional limits based on receiving water quality restrictions;
- The plant has undergone process modifications since the collection of data under the Effluent Monitoring Regulation - this may have introduced new pollutants;
- The plant has undergone expansion or added new facilities since the collection of data under the Effluent Monitoring Regulation;
- The proposed BAT(EA) facility has a potential land use conflict (for example, installation of a lagoon which may contravene existing zoning by-laws);
- There is a potential for adverse environmental impact during the construction and operation of treatment works (e.g. ground water contamination or odour problems).

A proposed detailed schedule showing the compliance timing steps under the Regulation is shown in Table 2 as an example. The schedule outlines steps leading to compliance following promulgation of the regulation for a sector. The dates shown in the compliance schedule will appear in the regulation.

During the interim period while dischargers install or modify facilities in order to comply with the BAT(EA) limits, the need and appropriateness of requiring them to meet interim limits based on their performance during the monitoring regulation period were discussed. However, no consensus was reached at the Issue Resolution Committee. Various opinions were expressed, each of which is outlined under the Unresolved Concerns below.

RECOMMENDATIONS

The position proposed by the Issue Resolution Committee on Compliance is as follows:

General

- Compliance with the Effluent Limits Regulation means that the discharger meets all the requirements of the regulation.

- Self-monitoring by dischargers would be required to demonstrate compliance with the Effluent Limits Regulation.

- All actions carried out by dischargers to meet regulation requirements would be subject to Ministry audit.

Limits

- Monitoring frequencies for compliance assessment with effluent limits should include the following:
    - A primary list of parameters having monthly average limits based on measurements taken daily or taken one day per week. Each daily or weekly measurement would also have a daily maximum limit.
    - A secondary list of parameters having a daily maximum limit based on a daily measurement taken once per quarter.
    - Daily monitoring is expected for those parameters that are indicative of the performance of the treatment facility. Weekly monitoring is expected for those key toxic substances and non-conventional parameters, and quarterly monitoring is expected for a long list of toxic contaminants.

- The average of four (4) weekly samples or 30 daily samples should be assessed for compliance with the monthly average limits; each daily or weekly measurement should also be assessed for compliance with the daily maximum limit. The daily measurement of once per quarter should be compared against the daily maximum limit.

- Monthly 30-day and 4-day averages should be calculated as the simple arithmetic mean using the replacement rules specified under the issue of Monitoring Data Analysis.

- The types of samples required for compliance assessment should be defined in the Effluent Limits Regulations and should be consistent with those required under the monitoring regulations.

- Plant limits based on a floating re-allocation of like contaminants among streams should not be allowed.

- Prior to BAT(EA) limits coming into force, however, plants should be given the opportunity to re-allocate contaminant loading limits among like streams at the same plant for the same contaminants provided that the overall regulatory loading limits assigned to that plant remain unchanged.

  After BAT(EA) limits come into force, re-allocation may be considered if it can be justified on the basis of overall reduction of contaminant loadings.

Enforcement

- Each violation would be subject to prosecution.

- The Ministry Compliance Policy should be clearly enunciated and applied consistently to all sectors.

Compliance Date

- All plants in a sector or sub-sector would be required to be in compliance with all regulation requirements for that sector or sub-sector after a period of time following the date of regulation promulgation.

- The period of time to come into compliance would be recommended on a sector-by-sector basis by each JTC, with full technical justification. All dischargers within a sector would be subjected to the same period of time. The maximum period of time allowed for a sector would be three (3) years.

- A mechanism to allow an extension beyond the compliance period upon demonstrated unusual circumstances beyond discharger's control, such as unforeseen extensive engineering or construction delays due to factors, such as natural disasters, or for start-up of unproven new technology, should be considered.

Approval of Works

Existing legislation requires dischargers to obtain approval under Section 24 of the Ontario Water Resources Act to establish, alter, extend, or replace sewage works.

- The regulation would specify the time for submission of the application for approval.

- The Ministry would screen and acknowledge applications for approval within a 10 day period; the acknowledgement would identify whether or not the application is complete and, therefore, accepted and, in the case of a complete application, it would identify which approvals process will be used, that is, either "fast track" or "detailed":

  Fast Track Approval
  A complete application would be processed within 90 days (following the 10 day screening period) from the date the application is acknowledged

  Detailed Approval
  A detailed review of the application would be required if:
  - Water quality-based limits are deemed necessary
  - New or expanded facilities are proposed
  - Process modifications are proposed which introduce pollutants that are not regulated
  - BAT(EA)-limits require construction of works, such as lagoons, where there is a potential for land use conflicts or other environmental risks (for example, groundwater contamination).

- Failure to submit a complete application within a specified time period should be considered to be a violation of the Effluent Limits Regulation.

- Incomplete applications should not be accepted for review.

- Dischargers should not be granted additional time beyond the compliance period because of their failure to submit a complete application for Ministry approval.

Interim Requirements

- There should be interim requirements in place to control dischargers during the period between the date of regulation promulgation and the effective date of regulation compliance.

UNRESOLVED CONCERNS *(Including Options)*

Interim Requirements

Alternative 1:

All plants should be required to meet Interim Requirements during the period between regulation promulgation and the date at which BAT(EA) limits come

into force. Dischargers should be in compliance with Interim Requirements 60 days after promulgation of the regulation.

The Interim Requirements would include interim pipe-specific effluent limits and interim toxicity compliance criteria, and would be developed from the monitoring regulation data. The Interim Requirements should be included in the Effluent Limits Regulation.

Interim Requirements would be based on the principle of no backsliding. For well operated BAT(EA) plants, the Interim Requirements would be the same as the BAT(EA) Limits. These interim limits would not be more stringent than the limits or the toxicity compliance criteria contained in the Effluent Limits Regulation, unless a plant has already achieved a more stringent level of control to protect a local sensitive receiver, as prescribed in the existing Certificate of Approval.

In recommending the Interim Requirements, Joint Technical Committees (JTCs) may give due consideration to changes in a plant's operation (process or production) which occurred after the collection of the monitoring regulation data and where the changes are deemed to have significantly modified a plant's performance in terms of effluent control.

Alternative 2:

In order to allow dischargers to install BAT(EA), and/or to improve the performance of existing BAT(EA), interim limits should not be imposed for the period between the date of regulation promulgation and the compliance date. During this period, dischargers' efforts would be directed toward installation of BAT(EA). Accordingly, there would not be a need to impose limits which could lead to possible prosecution, since treatment technology would not yet be in place. Instead, implementation of a self-monitoring control plan to be effective within six (6) months of promulgation is proposed. Quarterly reports would be used to demonstrate performance which could be verified by Ministry audit at any time. Repeated violations would be subject to requirements and conditions as directed under currently available abatement programs.

REFERENCES

1. U.S. EPA, The Enforcement Management System - National Pollutant Discharge Elimination System (Clean Water Act). Office of Water, 1986.

2. Revised Statutes of Ontario, 1980 Chapter 141, Environmental Protection Act. Ministry of the Attorney General, July 1989.

3. Sharma A., Weatherbe D., and C. Inniss " A Proposed MISA approach to setting limits and assessing compliance", Environmental Monitoring and Assessment Vol 12: 113-128., 1989.

4. Chemical Manufacturers Association et al. vs. U.S. Environmental Protection Agency, No. 87-4849. United States Court of Appeals, March 30, 1989 p. 104.

Appendix

Table 1

Typical Requirements for an application for Approval

- a completed application for approval form,
- a site plan showing the location of all industrial process units, sewage works, monitoring stations and outfalls
- process flow diagrams showing all sources of raw wastewater, expected flow rates (maximum, minimum and average), and all on-site and proposed sewage works,
- chemical and physical characteristics of the effluent stream entering the sewage works
- piping and instrumentation diagrams for the sewage works showing the location of all process controls, chemical addition points and monitoring stations,
- basis for design of all treatment equipment
- listing of all associated mechanical devices necessary to ensure proper operation of the sewage treatment.

Table 2

PROPOSED COMPLIANCE SCHEDULE*

(NOTE: This is an example based on 3 years; the exact compliance period is sector-specific and can be shorter. In such cases, the times shown would be adjusted accordingly)

DAY 0	-	File Regulation
	-	**Schedule A** of Regulation to specify pipe-specific interim limits for each plant -- as developed from Monitoring Regulation data [interim limit will be based on the principle of no backsliding -- interim limit will not be more stringent than BAT(EA) limit
	-	**Schedule B** of Regulation to specify plant- or pipe-specific BAT(EA) limits which are equitably derived from generic sector/sub-sector BAT(EA) limits
DAY 60	-	Start monitoring for compliance with interim limits
DAY 180	-	Plants which require upgrading/ or installation of treatment works to meet BAT(EA) limits are required to submit an Application for a Certificate of Approval for capital works
DAY 190	-	Ministry to acknowledge receipt of complete application and identify appropriate review process (fast track review or a detailed review)
DAY 280	-	Ministry to provide Approval for works that qualify for fast track approach.
-- -- ---		Industry to file Notice of Intent to re-allocate pipe limits within allowable plant total [notice must be received prior to Schedule B being in-force]
DAY 1095	-	All BAT(EA) must be in place. **Schedule B** will have been amended to reflect re-allocation requests -- final plant- and pipe-specific limits stated in Schedule B will come into force

* If detailed review of application is required, time to achieve compliance with Schedule B, may be subject to change.

Under this timetable, compliance with interim limits would be achieved within 60 days for all dischargers. Compliance with BAT(EA) limits would be achieved 3 years following promulgation. Specific conditions may be incorporated into the C of A to incorporate water quality-based limits or other unique considerations.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

MONITORING FOR ASSESSMENT

ISSUE

To set criteria for the monitoring of non-limited parameters (excluding monitoring for compliance) under the Limits Regulation.

BACKGROUND

Monitoring under the Effluent Limits Regulations can be classified according to the intended end-use of the data, as follows;

- monitoring of parameters under limits (limited parameters) for evaluating compliance with the regulatory limits,

- monitoring of parameters with no specified limits (non-limited parameters) for assessing discharge levels and presence/absence status.

The monitoring of limited parameters is discussed in the Final Report of the Issue Resolution Committee on Compliance and will not be covered in this document.

The Effluent Monitoring Priority Pollutant List (EMPPL) is a list of toxic pollutants that have been detected or are potentially present in Ontario municipal and industrial effluents and pose a hazard to the receiving environment[Ref.1]. Non-limited parameters are those parameters on the EMPPL for which no limits have been set because the parameters were not detected in the data base from the regulatory one year monitoring period or because there is no current demonstrated BAT(EA) treatment technology to remove them (non-BAT(EA) parameters).

Non-limited parameters require periodic monitoring:

- to ensure that there have been no significant changes to the database on which the original decision to exclude the parameters from limits was based,

- to establish on-going loading levels to determine if they are environmentally significant to warrant additional remedial measures,

- to provide presence/absence data for parameters for which no previous monitoring had been done because the parameters were new additions to the EMPPL or have just had standard analytical methods developed for them,

- to provide data on the performance of new technology with BAT(EA) potential for the future setting of limits.

The objective of this Report is to recommend criteria for the monitoring of non-limited parameters.

DISCUSSION

U.S. EPA Experience

Monitoring for non-limited parameters was not covered in the U.S. EPA national effluent regulations. Individual States set their own monitoring requirements with no specific rules used for setting monitoring frequencies. Frequency assignments vary from State to State and are based largely on Best Professional Judgement (BPJ). For instance, in Michigan State dischargers are required, depending on size, to perform a characterization of their effluent streams once every three years[Ref.2]. In New York State however, some dischargers are required to characterize their effluent streams on an annual basis for a selected number of pollutants, although the recent trend has been to include all analytical test groups[Ref.3].

On renewal of a discharge permit, which normally occurs every five years, the NPDES requires that dischargers characterize their effluents for a specific list of pollutants. The list of pollutants (excluding pesticides) is identical for twenty-six of the thirty-four industrial categories covered. The pollutants required to be monitored include those in the volatiles, acid extractables, base/neutral, pesticides and metals analytical test groups. If additional pollutants are known or expected to be present in the effluent streams, these will also be required to be quantified[Ref.4].

Monitoring under the MISA Program

It is intended that contaminants which have been determined to be significant in specific effluent streams will be limited and required to be monitored on a daily, weekly and quarterly basis for the purposes of determining compliance with the effluent limits.

The frequency of monitoring of non-limited parameters for assessment should reflect the information needs for which the data are required. It should also be less onerous than the compliance monitoring frequency.

In an effort to minimize monitoring for non-limited parameters and yet satisfy data needs, it is proposed that a quarterly monitoring frequency be required for all non-BAT(EA) parameters for the purposes of estimating annual loadings. These parameters would have been detected at significant levels and frequencies during the regulatory one year monitoring period. As the selection of the BAT(EA) parameters would be on a sector/sub-sector basis, non-BAT(EA) parameters would consequently be listed on a sector/sub-sector basis. For non-BAT(EA) parameters which are unique to a particular site in a sector/sub-sector however, BPJ may be used by the Joint Technical Committee to recommend quarterly monitoring for those particular non-BAT(EA) parameters associated with that site only.

To provide data on the presence/absence of other EMPPL contaminants in effluent streams, one group of Issue Resolution Committee members proposed that a full EMPPL characterization be conducted. This type of monitoring for the purposes of presence/absence determinations would provide an on-going database on the general characteristics of each process/combined effluent stream and will indicate if these characteristics have changed significantly since the one year regulatory monitoring period on which the limit setting process was based.

Where the characterization frequency for the full EMPPL cannot be justified for simple or small plants, consideration should be given to relaxation of the characterization requirements taking into consideration recommendations of the Joint Technical Committee (JTC). Relaxation of these requirements may take the form of both a frequency reduction and/or a shortened EMPPL based on BPJ exclusion of parameters known not to be present in a given sectors effluent.

An additional allowance has been proposed for relaxation of the characterization monitoring requirements for sites which have long retention/equalization times (typically months) in their effluent treatment systems and for those which have biological and carbon treatment of their effluent streams. This proposal is based on the argument that the effluent quality would be non-variable for treatment systems which have long equalization times and where biological/carbon treatment systems are used, the likelihood of discharging significant levels of undiscovered chemicals would be low.

Open scans gas chromatography/mass spectrometer analysis should be required for all samples used for any EMPPL characterization. New compounds found would be reviewed for possible addition to the EMPPL by the Ministry.

The quarterly frequency for non-BAT parameters will not in itself provide a sufficient number of data points for the purposes of setting future limits on specific contaminants. Thus, it is proposed that the Ministry may, where necessary through the JTC, require dischargers to conduct more intensive monitoring on effluent streams for the purposes of setting future limits for compounds for which BAT(EA) becomes available. For non-BAT(EA) parameters, the Ministry may in addition conduct studies of dischargers treatment systems for technology development.

Effluent limits are intended to be imposed for chemicals added to non-contact cooling water streams. Quarterly monitoring is recommended in order to assess compliance with these limits. A need therefore arises to assess those contaminants which are not limited but which may originate from other sources such as from process leaks. An annual assessment monitoring frequency is therefore proposed for all non-contact cooling water effluent streams. Parameters to be monitored would be on a site-specific basis and would be based on BPJ. To allow for the assessment of contaminants originating from process leaks, there will be a requirement to analyze intake water at the same frequency for an identical list of parameters.

Another group of IRC members propose the use of sub-sectoring for the MFA program as an alternative approach that could be adopted for the purposes of monitoring non-limited parameters. Process and combined effluent pipes would be grouped into a largely

homogeneous group for the purposes of defining monitoring requirements. This approach would allow sites to monitor only for contaminants which have been found within the sub-group. In addition, a sub-sector EMPPL would be monitored annually, with the sub-sector EMPPL expanded to a full EMPPL every second year. In selecting the sub-sector EMPPL, classes of compounds on the EMPPL that are clearly associated with specific sub-sectors should be deleted from the EMPPL monitoring list for other sectors. Also compounds which are detected at specific sites should require monitoring at those sites only, on recommendation of the JTC.

RECOMMENDATIONS

The proposals of the Issue Resolution Committee on Monitoring for Assessment are as follows:

- Quarterly monitoring should be required for all non-BAT(EA) parameters for each process/combined effluent stream in a sector or sub-sector.

- Where non-BAT(EA) parameters are unique to a particular site in a sector/sub-sector, at the recommendation of the Sector Joint Technical Committee, quarterly monitoring for those particular non-BAT(EA) parameters may only be required on a site-specific basis.

- Open scan analyses should be required as part of any EMPPL characterization.

- Semi-annual monitoring is required for all new EMPPL compounds for each process or combined effluent stream.

- Full EMPPL characterization should be required each time there is a significant change to the process that is expected to adversely impact the quality of the process effluent.

- A discharger may be required to conduct more intensive monitoring for the purposes of demonstrating performance of new technology with BAT(EA) potential.

- The Ministry may conduct its own studies of discharger treatment systems for technology development where it is deemed necessary.

- Annual assessment monitoring would be required for non-contact cooling water effluent streams; monitoring parameters would be selected based upon BPJ. Intake water would be analyzed at the same frequency and for the same parameters as the non-contact cooling water effluent stream.

UNRESOLVED CONCERNS *(Including Options)*

EMPPL Characterizations

Alternative 1:

Semi-annual characterization should be required for the full EMPPL (including open scans) for each process and combined effluent stream.

Full EMPPL characterizations are required on a semi-annual basis to ensure that there are no significant changes to the data base obtained under the one year regulatory monitoring period on which the limit setting process was based.

Where the semi-annual characterization frequency for the full EMPPL does not seem justified for simple or very small plants, on the recommendation of the Sector JTC, the Ministry can consider relaxation of the requirements.

Relaxation of these monitoring requirements may take the form of both a frequency reduction to once per year and a shortened EMPPL based on Best Professional Judgement (BPJ) exclusion of parameters which are not associated with the process operations of the sector or sub-sector.

Alternative 2:

Sub-sectors should be developed by the JTC for the purposes of Monitoring for Assessment. The sub-sectors, which may be different than those developed for the purposes of BAT selection, would be largely homogeneous with respect to process and chemicals used and would be developed using BPJ.

A sub-sector EMPPL should be developed. The sub-sector EMPPL would be comprised of compounds which are potentially present, or have been detected based on previous data collected, in the sub-sector effluents.

The sub-sector EMPPL should be monitored for the purposes of assessment on an annual basis. The sub-sector EMPPL would be expanded to a full EMPPL every two years.

REFERENCES

1) Ontario Ministry of the Environment, "The Effluent Monitoring Priority Pollutant List - 1988 Update", March 1989.

2) McCracken, William. 1990. Personal communication, Michigan Department of Natural Resources, Lansing, Michigan.

3) Halton, Dan. 1990. Personal communication, New York State Department of Environmental Conservation, Albany, New York.

4) U.S. Environmental Protection Agency, "40 Code of Federal Regulations, Chapter 1, Section 122.21 g(7)", January 7, 1988.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

STORMWATER

ISSUE

To define the procedures for assessing stormwater and for regulating stormwater under the Effluent Limits Regulations.

BACKGROUND

Existing practices and designs for most industrial and municipal plant stormwater drainage systems efficiently direct stormwater and surface drainage towards natural receiving waters. While affording desirable protection against the loss of both property and life, it is widely accepted that these practices have the potential to degrade the water quality of receivers and result in the reduction or loss of associated water uses (for example, swimming, fishing, and outdoor recreation).

Recent studies have identified the importance of non-point sources of pollution; especially the role of stormwater and its accumulative impact on natural receiving waters. These studies (Toronto Area Watershed Management Study, Rideau River Stormwater Management Strategy, Metro Toronto Remedial Action Plan, and North Bay and St. Catharines Pollution Control Planning Studies) demonstrated that in the absence of point sources of pollution, contaminated stormwater was a major contributor to the degradation of water quality, restriction of water uses and the destruction of fish stocks and aquatic habitats.

Industrial and municipal plant site stormwater runoff has the potential to be more contaminated than that from other land uses due to their more intensive production and waste management activities. It has been documented that industrial site stormwater has higher levels of suspended solids, metals and other site specific toxic parameters.

DISCUSSION

The Effluent Monitoring Regulations require the collection of data on stormwater quality and quantity from the municipal and all industrial sectors. The purpose of the data is to determine for the municipal and the various industrial sectors, sub-sectors or plants if effluent limits can be developed for stormwater or whether further studies are required.

For the purposes of examining the impact of stormwater discharges, a plant may be divided into outdoor process areas and outdoor non-process areas. The outdoor process areas may be further sub-divided into:

- Outdoor process activity areas which include outdoor production facilities
- Material handling areas and storage areas which include raw material and product storage areas, tank farms and waste disposal sites. Roof drainage from buildings housing production or process facilities are included in this outdoor area category.

The outdoor non-process areas of a plant may be divided into two areas:

- Developed outdoor non-process areas
- Undeveloped outdoor non-process areas.

Each sectoral Joint Technical Committee should examine these area definitions and, if necessary, re-define them for the sector.

RECOMMENDATIONS

The following comprise the recommendations of the Issue Resolution Committee on Stormwater:

Limit Setting

- Outdoor process areas and developed outdoor non-process areas of a sector or sub-sector should be regulated by effluent limits for pollutant parameters, provided there is a BAT(EA) for the treatment of stormwater or surface runoff streams; these effluent limits may be based on concentrations or loadings depending on sector- or sub-sector-specific conditions.
- The stormwater effluent limits development process would follow the same procedures used for development of limits for process effluent streams.
- If limits cannot be developed, the stormwater data collected by the Effluent Monitoring Regulations would be used to determine future actions at the plant site.

Stormwater Control Studies

- If stormwater limits cannot be established for the sector, dischargers may be required to conduct a Stormwater Control Study and implement the study results, if the stormwater, or surface runoff, from outdoor process areas and/or from developed outdoor non-process areas at the site exceeds the BAT(EA) limits for process effluents for that sector.
- The purpose of the Stormwater Control Study is to develop a stormwater pollution control plan for the entire plant site. The study is comprised of three phases:
    1) Outline the nature, causes and extent of the stormwater pollution problems
    2) Propose alternative remedial measures
    3) Recommend an implementation program.

The first phase of the study comprises monitoring, investigations and assessment tasks. These tasks would include: water quantity and quality monitoring of all stormwater drainage systems leaving and entering the plant site during storm events and non-storm events, and detailed stormwater drainage system investigations when non-compliance stormwater data are recorded.

In the second phase stormwater pollution sources are prioritized and alternative remedial measures are selected and evaluated. This phase may include but is not limited to modelling studies of the drainage system and its pollution sources. Simple stormwater estimation techniques maybe appropriate in some cases. Ministry concurrence on proposed approaches is suggested.

Dry weather pollution sources identified early in the second phase should be abated as soon as possible. The industry would be expected to disconnect cross-connections to the stormwater drainage system.

Remedial measures being evaluated would vary depending on the severity of the problem. If only minor control of stormwater is required source controls maybe adequate and may include:

- Sediment and erosion control during development or redevelopment
- Spill control (such as berms, dikes, or containment)
- Raw material and storage controls
- Waste material and litter control
- Housekeeping (such as spill cleanup, process and pavement area sweeping, and catchbasin cleaning)

If the stormwater problem is more severe structural controls maybe required. These controls may include:

- Infiltration techniques (such as trenches, ditches, and basins) *Note: These techniques are not recommended for outdoor process areas.*
- Stormwater ponds (such as wet, extended wet and extended dry ponds)
- Oil/Grit Separators

To ensure that both Source and Structure Controls are operating efficiently, maintenance is required.

The third phase would be the development of the final implementation plan.

- The JTC may develop generic sector, sub-sector or plant criteria for the Stormwater Control Study. The generic conditions should include the investigation and assessment requirements, proposed remedial measures, design factors and codes of practice used in the sector as well as other related regulations and legislation. For example, in the Mining Sector, the tailings impoundment design and closures are regulated by the Lakes and Rivers Improvement Act, the Mining Act and the Ontario Water Resources Act. Expected environmental benefits will be a criteria for developing a Study.

- Stormwater Control Studies would be imposed on a site-specific basis.

- Stormwater or surface runoff from undeveloped outdoor non-process areas would not be regulated and would not require a Stormwater Control Study.

- Dischargers would have six months to develop a Stormwater Control Study plan and twenty-four months to carry out the study.

- Implementation of the Remedial Measures derived from the Study should not be part of the regulation; however, the implementation of these measures may be carried out by three options:
    - Issuing a Control Order
    - Amending the Effluent Limits Regulation
    - Delaying implementation until the next scheduled regulation update (five years).

Stormwater Monitoring

- If stormwater limits cannot be established for the sector, and if the quality of the stormwater at a site does not exceed the BAT(EA) limits for process effluents within that sector but does exceed the concentrations considered to be at the level of "virtual elimination", then the discharger may be required to continue monitoring stormwater for the purpose of assessment. The frequency of this monitoring would be determined on a site-by-site basis.

- In addition, monitoring for assessment requirements may be developed on a sector-wide basis to assist in the development of future stormwater limits; these requirements would be included in the Effluent Limits Regulation for the sector.

UNRESOLVED CONCERNS *(Including Options)*

Net Loadings in the Context of Stormwater

Alternative 1:

In assessing stormwater, because of the large number of industrial sites in the province, care must be taken in setting criteria for conducting studies on an industry-wide basis without information on environmental significance and site specific factors. Thus, the JTC should consider the quality of off-site stormwater entering the plant site, naturally occurring stormwater contamination, and environmental effects.

Alternative 2:

In assessing stormwater, the concept of net loadings is generally not allowed, except under the provisions listed in the issue of Net Loadings.

DEFINITIONS

combined effluent means an effluent resulting from the intentional combination of process effluent and cooling water or process effluent and stormwater or process effluent, cooling water and stormwater or cooling water and stormwater

cooling water means water and associated material that is used in an industrial process for the purpose of removing heat and that is not intended to come into contact with process materials

effluent means any liquid and associated material discharged, directly or indirectly, to a surface watercourse

once-through cooling water means cooling water that has been circulated once through heat transfer equipment and that is discharged, directly or indirectly, to a surface watercourse

outdoor process areas means outdoor areas of the plant associated with process areas (outdoor production facilities and material handling areas) and storage areas (raw material and product storage areas, tank farms, and waste disposal sites)

outdoor non-process areas means developed outdoor non-process areas (for example: office buildings, parking lots, roadways, and lawns) and undeveloped outdoor non-process areas (for example, woodlots) of the plant not associated with process areas

plant means an industrial or municipal facility and the developed property and waste disposal sites associated with it

storm event in relation to a plant means a rainfall or series of rainfalls on an operating day that exceeds five millimetres as measured by a rain gauge within two kilometres of the plant or an Environment Canada meterological station within eight kilometres of the plant

stormwater means run-off from a storm event or thaw that is discharged from a process or non-process area of a plant directly or indirectly to a surface watercourse

thaw in relation to a plant means the melting of snow or ice sufficient to create an effluent stream at the plant

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

BY-PASSES

ISSUE

By-passes may occur at industrial plants and in municipal collection and treatment facilities. The purpose in examining this issue was to develop procedures by which by-passes may be incorporated into the Effluent Limits Regulation for each sector or sub-sector.

BACKGROUND

By-passes

By-passes are the diversion of process or waste streams, once-through cooling water, stormwater, surface runoff or infiltration from any part of a plant or waste treatment facility or collection system that results in the discharge of untreated or inadequately treated effluents to the receiving waters.

By-passes at industrial and municipal plants may be one of three types:

- By-passes which are stormwater or surface runoff or infiltration driven events at industrial sites
- By-passes which are stormwater or surface runoff or infiltration driven events in municipal collection and treatment systems (including so-called combined sewer overflows, or CSOs)
- By-passes which are non-stormwater or non-surface runoff or non-infiltration driven events.

There are significant differences between the "by-passes" in industrial and municipal sectors. In the industrial sector, "by-passes" are not routine conditions of operation. They are used during unusual circumstances of operation. In the industrial sector, all wastes collected and treated are, within reason, generated by the industry itself and are controlled by the industry itself, with the exception of stormwater.

In the municipal sector, by-passes are more difficult to control since the collection system is much more extensive than those used by industry. The municipal collection system can allow a considerable amount of extraneous infiltration and stormwater to enter, causing by-passes to occur. In addition, the wastes being treated by the municipal sector are generated by hundreds or thousands of individual sources, thus, a municipality has a lesser degree of control over each source of waste than an industry.

Combined Sewer Overflows

Combined sewer overflows (CSOs) are undesirable discharges containing stormwater and sewer infiltration and one or more of the following: untreated or partially treated industrial, commercial, and/or residential wastewaters, and/or once-through cooling water.

These discharges have been designed into the municipal sanitary collection system to ensure that capacity requirements are not exceeded in the collection or treatment systems. CSOs may discharge into natural receiving waters.

A major concern of CSOs is the public health risk associated with the discharge of untreated sanitary effluent which may contain viruses and pathogenic bacteria. Typical CSOs in Ontario have 10^6 - 10^7 fecal coliform organisms/100ml. Therefore, even with high dilution, CSOs pose a risk to recreational swimming areas (Ontario has a health criteria of 10^2 fecal coliform organisms/100 ml). Generally, this elevated risk may persist 1-3 days after a CSO occurs.

Water quality impacts from CSOs include dissolved oxygen depression, eutrophication, sediment contamination, and chronic and/or acute toxicity. These impacts are dependent on the volume and frequency of the overflow and the receiving water's assimilative capacity. Generally the larger the receiver the less the immediate impact of CSOs. Long term impacts may be a concern from industrialized combined sewer areas.

RECOMMENDATIONS

The following proposals are provided by the Issue Resolution Committee on By-passes:

By-pass Control

- By-passes should be prohibited, unless:
  - The by-pass was unavoidable to prevent loss of life, personal injury or severe property damage, and was not caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operations
  - No feasible cost-effective alternatives to the by-pass exist, such as the use of auxiliary treatment facilities, retention of untreated or partially treated wastes, maintenance during normal periods of equipment downtime or adequate back-up equipment
  - The stormwater, surface runoff, or infiltration event which caused the by-pass exceeded specified design capacity criteria set out in the Effluent Limits Regulation
  - The stormwater, surface runoff, infiltration, untreated, or partially treated effluent did not exceed the effluent limitations for that stream and the by-pass was for essential maintenance to assure continued operation.

- Capacity criteria should be developed for controlling by-passes in a sector or sub-sector; this may be accomplished by utilizing sector specific standard codes of practice, design criteria, and/or regulatory practices from other jurisdictions. These capacity criteria and the time the discharger will have to develop and implement any by-pass control requirements should be included in the Effluent Limits Regulation.

- If a direct discharger knows in advance of the need for a by-pass the discharger shall submit written notice to the Ministry at least ten days before the date of the proposed by-pass. The written notice should contain a description of the proposed by-pass, including the exact date and duration of the proposed by-pass, and the steps to be taken or planned to eliminate the need for the proposed by-pass in the future.

- The Ministry's Regional Director may approve an anticipated by-pass, after considering its adverse effects, if the Director determines that it meets the exception criteria provided above.

- If a discharger has an unanticipated by-pass, the discharger shall submit oral notice of the unanticipated by-pass to the Ministry as soon as the discharger became aware of the by-pass. The oral notice should provide a description of the by-pass, including the exact date and duration of the by-pass, and if the by-pass is continuing, the time it is expected to stop, and the steps to be taken or planned to reduce and eliminate the by-pass. In addition, the discharger shall also submit written notice within 5 days of the time of the by-pass. The written notice should contain a description of the by-pass, including the exact date and duration of the by-pass, and if the by-pass is continuing, the time it is expected to stop, and the steps to be taken or planned to reduce, eliminate, and prevent the recurrence of the by-pass.

Combined Sewer Overflow Control

- Combined Sewer Overflows (CSOs) should be abated on a site-specific basis.

- The approach to CSO abatement should involve:
    - Identifying and quantifying the amount of CSO to be controlled
    - Undertaking a CSO Control Study to evaluate various remedial measures and techniques
    - Developing an implementation plan that is economically achievable for the municipal direct discharger.

- The JTC may adopt the Ministry's current technical guidelines for conducting Pollution Control Planning (PCP) studies or develop their own specifically for the CSO Control Studies.

The objective of a PCP is to outline the nature, cause and extent of pollution problems within a defined area (generally a municipality), propose alternative remedial measures, and recommend an implementation plan. A PCP normally covers three main phases:

Phase 1) Define the problem, that is the nature, cause and extent of pollution

Phase 2) Evaluate control options and propose alternative remedial measures

Phase 3) Develop a Pollution Control Plan and recommend an implementation program.

The guideline should include the identification, investigation and quantification, proposed remedial measures and assessment procedures, and the specified design criteria for CSO control. Expected environmental benefits would be a criteria for developing the Plan.

- The approach to Combined Sewer Overflow (CSO) abatement involves identifying and quantifying the amount of CSO to be controlled, evaluating various remedial measures and techniques, and developing an implementation plan that is economically achievable for the municipality(s) to carry out. Unlike industrial or municipal effluent, CSO occurs randomly, pollutant composition is highly variable and receiving water assessments are difficult to conduct. To date very few municipalities with CSOs have carried out this evaluation and planning. The few municipalities that have conducted this work have done so in conjunction with a Pollution Control Planning (PCP) study.

- The Municipal Sector JTC should develop design capacity criteria and treatment requirements that are BAT(EA) for combined sewer overflows. CSO Control Studies should be developed to priorize capital expenditures for municipal pollution abatement for CSOs.

- Municipal direct dischargers would have thirty-six months to develop and carry out a CSO Control Study

- Implementation of the Remedial Measures derived from the CSO Control Study should not be part of the Regulation; however, implementation may carried out by one of three options:
  - Issuing a Control Order
  - Amending the Effluent Limits Regulation
  - Delaying implementation until the next scheduled regulation update (five years).

UNRESOLVED CONCERNS *(Including Options)*

Conditions Under Which By-passes Should be Allowed

Alternative 1:

By-passes should be prohibited, except under those conditions recommended above.

Alternative 2:

A by-pass for a stormwater or surface runoff event should be allowed for an existing industrial or municipal plant when the stormwater or surface runoff exceeds the capacity criteria specified in the existing Certificate of Approval for the plant.

In addition, each JTC may develop criteria to allow by-passes, other than those listed above, where by-passes are an integral part of the optimization of the effluent treatment plant performance. Further, each JTC may develop other specified criteria that would allow by-passes provided they can be justified.

Each JTC should develop capacity criteria for allowing by-passes in the sector or sub-sector. This may be accomplished by utilizing sector specific standard codes of practice, design criteria and regulatory practices from other jurisdictions. These capacity criteria and the time the discharger would have to develop and implement any by-pass requirements should be included in the Effluent Limits Regulation. If an existing or new plant does not have capacity criteria in its existing Certificate, the capacity criteria provided in the sector Effluent Limits Regulation should be added to the Certificate.

DEFINITIONS

by-pass means the diversion of untreated or partially treated process streams, once through cooling water, stormwater, surface runoff, infiltration or waste streams from any part of a plant or waste treatment facility or collection system that results in the discharge of untreated or inadequately treated effluent to the natural receiving waters

combined effluent means an effluent resulting from the intentional combination of process effluent and cooling water or process effluent and stormwater or process effluent, cooling water and stormwater or cooling water and stormwater

combined sewer overflow means the designed diversion of a discharge comprised of stormwater and sewer infiltration and one or more of the following: untreated or partially treated industrial, commercial, and/or residential wastewaters, and/or once-through cooling water, from any part of a municipal sanitary collection system that results in a discharge to the natural receiving waters

cooling water means water and associated material that is used in an industrial process for the purpose of removing heat and that is not intended to come into contact with process materials

effluent means any liquid and associated material discharged, directly or indirectly, to a surface watercourse

notice of an anticipated by-pass means a written notice submitted at least ten days before an anticipated by-pass which provides details of the proposed by-pass

notice of an unanticipated by-pass means oral notice which provides information on the unanticipated by-pass as soon as the discharger becomes aware of the by-passs, and written notice which provides details of the by-pass within five days of the time the discharger became aware of the by-pass

once-through cooling water means cooling water that has been circulated once through heat transfer equipment and that is discharged, directly or indirectly, to a surface watercourse

oral notice means a description of the by-pass, including the exact date and duration of the by-pass, and if the by-pass is continuing, the time it is expected to stop, and the steps to be taken or planned to reduce and eliminate the by-pass

plant means an industrial or municipal facility and the developed property and waste disposal sites associated with it

severe property damage means substantial physical damage to property, damage to the treatment facilities which cause them to become inoperable or substantial long-term loss or impairment of the natural resources which can reasonably be expected to occur in the absence of a by-pass. Severe property damage does not mean loss caused by delays in production

storm event in relation to a plant means a rainfall or series of rainfalls on an operating day that exceeds five millimeters as measured by a rain gauge within two kilometers of the plant or an Environment Canada meterological station within eight kilometers of the plant

stormwater means run-off from a storm event or thaw that is discharged from a process or non-process area of a plant directly or indirectly to a surface watercourse

thaw in relation to a plant means the melting of snow or ice sufficient to create an effluent stream at the plant

written notice shall contain a description of the by-pass, including the exact date and duration of the by-pass, and if the by-pass is continuing, the time it is expected to stop, and the steps to be taken or planned to reduce, eliminate, and prevent the recurrence of the by-pass.

FINAL REPORT OF THE ISSUE RESOLUTION COMMITTEE ON

REPORTING TO THE PUBLIC

ISSUE

To define what constitutes meaningful, accurate and responsible reporting to the public and to set criteria for report development and release. Issues which were addressed can be summarized under three main headings:

1. *Confidentiality of Industry and Municipality data and information.*
2. *Procedures for responding to Public requests for MISA data.*
3. *Scope, content and format of MISA reports.*

BACKGROUND

The Ministry of the Environment has stated in the White paper that:

> *"The public will have complete access to data on contaminant discharges to surface waters and on the effluent limits set for all dischargers. They will know which dischargers are in compliance, which dischargers have to implement further pollution abatement and the status of individual abatement programs" (MOE, 1986).*

DISCUSSION

The main principles provided in the Freedom of Information Act would be followed for release of MISA data to the public. In section 1 of the Act, it states that the purpose is to provide a right of access to information with the principles that:

1. Information should be available to the public.

2. Necessary exemptions from the right of access should be limited and specific.

The treatment of proprietary information supplied by dischargers is governed by section 17 of the Freedom of Information Act. The reporting of data would comply with these requirements.

With respect to generating MISA reports, it would be necessary to ensure that the reports satisfy the public need for information, and constitute meaningful, accurate and responsible reporting.

While it is agreed that the public should have access to data on contaminant discharges to surface waters from all sources, there is a need to ensure that the information released to the public is accurate and not misleading, so that the public is properly informed of the true nature of discharges to the environment. In order to accomodate this need, the Ministry of the Environment should take whatever steps are necessary to ensure that their reports represent an accurate picture of the discharger and of the results obtained

from monitoring carried out under the monitoring and limits regulations. In addition, confidential information, which could potentially affect competitiveness and financial stability, should not be released to the public or other dischargers.

U.S. EPA APPROACH

The U.S. EPA has had considerable experience in releasing data to the public and the associated confidentiality considerations. The approach generally followed is presented below.

Effluent data, within the context of the U.S. EPA is not eligible for confidential treatment, and a detailed definition of effluent data is contained in the Clean Water Act. A business may assert a confidentiality claim on selected information, however, any final determination of confidentiality is made by the EPA office, using the guidelines contained in the Clean Water Act.

Any environmental data collected by EPA on a routine basis or for special studies is stored in the federally operated STORET System. The data is made available to public agencies, and indirectly to the public.

Dischargers must submit data to state or federal regulatory agencies as required in regulations promulgated under the Clean Water Act. In turn, the regulatory agencies must submit compliance information to the EPA on a quarterly basis. The Quarterly Non Compliance Report (QNCR) contains details of reportable non-compliance occurrences as specified in a reporting regulation. The information is recorded in a computer system - the Permit Compliance System(PCS) - which produces reports primarily used by environmental agency officials. The main purpose of the reporting regulation and the PCS is to focus abatement and enforcement efforts on significant non-complying dischargers.

Information on non compliance is available in raw form to the public at selected locations such as state agency offices or regional EPA offices. In addition, EPA will make available any information in the PCS under Freedom of Information requests, with the exception of details of enforcement actions in progress. Confidential Business Information is not maintained on the system.

The majority of the requests consist of descriptive information and mailing lists for use in marketing efforts, followed by site specific requests on dischargers by environmental interest groups.

RECOMMENDATIONS

The recommendations by the Issue Resolution Committee on Reporting to the Public can be broken down into 3 main headings:

- Confidentiality of Industry/Municipaltiy data and information

- Procedures for responding to public requests for MISA data
- Scope, Content, and format of MISA reports

Confidentiality of Industry/Municipaltiy Data and Information

The members of the Issue Resolution Committee on Reporting to the Public could not reach agreement on this topic; consequently, the alternative viewpoints are presented in the following section on Unresolved Concerns.

Procedures for Responding to Public Requests for MISA Data

- 4 types of reports should be provided to the public:
  - Press Releases, covering letters, and the like
  - Regulation Development Reports
  - Standard Ministry-issued Reports
  - Ad hoc requests

Press Releases, covering letters, and the like
These reports would be prepared and issued by the Ministry. The Ministry would send copies upon release to any directly-affected parties. This policy is consistent throughout the government of Ontario.

Regulation Development Reports
These reports, which include Monitoring and Limits Regulation development documents, would be developed in conjunction with each sector JTC, since these outline the format and content of each sector regulation. In addition, prior to release for public comment and subsequent promulgation, these documents would be reviewed with the appropriate sector JTC.

Standard Ministry-issued Reports
These are standard reports developed and issued by the Ministry for reporting status of regulation activities including sampling, enforcement, compliance, QA/QC data, audits, and the like. With respect to these reports, the content and format of these reports would follow the formats provided later.Special sector issues should be addressed within each sector JTC.

Ad hoc requests
When a general request is made by a member of the Public for MISA data, the Ministry would satisfy the requests by supplying the standard Monitoring and Limits Regulation reports. However, the Ministry has made a commitment to give the public access to MISA data, and would provide data for specific public ad hoc requests. Any significant ad hoc requests (those requiring significant effort on the part of Ministry staff) may be handled under the FOIA to allow for handling and material costs (these costs

could be waived where it is fair and equitable to do so - see section 57(3) of the FOIA). Should a specific request be made by the public, reports would normally consist of the specific data with a qualifier included(see Attachment 1), but no interpretation. This type of report would be reviewed internally prior to release. As a courtesy, the affected plant(s) would be notified that a request had been made and would be told the nature of the data provided.

Scope, Content, and format of MISA reports

- The reporting of MISA data to the public is an important requirement of the MISA program; however, it is essential that such reporting be accessible, easily understood, meaningful and timely. In order to provide meaningful reports, the Ministry would make every effort to relate the data to the MISA objective of controlling toxic contaminants from effluents flowing into Ontario waterways.

- With respect to the monitoring of contaminants, the reports would:
    - Segregate the data into toxic categories relevent to the MISA objective
    - Provide an indication of contaminant loadings trends since the MISA starting point (the 12-month monitoring period) plus an indication of what remains to meet the objective of virtual elimination, relevant to the MISA objective
    - Provide an opportunity to place the loadings of toxics into an overall context by:
        - Relating the contribution of individual dischargers to that of the total sector/sub-sector
        - Relating the contribution of one industry sector to that of all industrial discharger sectors and the municipal sector.

- In the interest of avoiding misunderstandings, the reports would include guidance for interpretation of data, where appropriate.

- In order to avoid confusion with the public, consistent units would be used, whenever possible.

- Data sets containing results which are < RMDL values would be reported as follows:
    - For data below RMDL, range (0 to RMDL) would be used to estimate and report averages of concentrations and loadings
    - Data equal to or greater than RMDL would be reported as they are.

- Intake water data would be reported along with effluent data, where applicable.

- Net loadings would be reported for non-contact once-through cooling water streams.

- Reporting would be consistent with the resolution of the other Issues.

- It is intended that the MISA reports would include data provided under the Monitoring and Limits regulations. They would also include the status of compliance of MISA dischargers against these regulation requirements, as well as programs to attain compliance.

- The Report on Industrial Direct Dischargers in Ontario would continue to be published, and would eventually evolve into a Compliance Summary Report.

- There would be a development document for each sector to accompany the Limits Regulations when they are released for public comment.

- The MISA reports would include the following:
    - Information Received under the Monitoring Regulations
        - Six-Month Monitoring Regulation Summary Report *(Petroleum and Organic Chemical Regulations only)*
        - Monitoring Regulation Summary Report
        - Report on the Industrial Direct Dischargers in Ontario
        - MISA Aggregate Twelve-Month Monitoring Summary Report
    - Supporting Document for Limits Regulation
        - Limit Regulation Development Document for each sector
    - Information Received under the Limits Regulations
        - Semi-annual Compliance Summary
        - Annual Direct Discharger Monitoring and Compliance Summary

The appended tables provide tentative tables of contents for the planned MISA Reports.

Confidentiality of Industry/Municipaltiy data and information

Alternative 1:

The public would have access to data on contaminant discharges to surface waters and on the effluent limits set for all dischargers. Nevertheless, there is a need to identify and protect plant confidential information. All data claimed by sector plants to be confidential must meet certain criteria in order to be designated as such by the Ministry. Notwithstanding "effluent data", which is public information, the Freedom of Information Act (FOIA) would be used as the basis for this determination, in dealing with both ad hoc and FOIA requests.

Definition of Effluent Data (based on USEPA definition)
All information in respect of the deposit, addition, emission or discharge of a contaminant into the natural environment, including:

- Information necessary to determine the identity, amount, frequency, concentration, temperature, or other characteristics (to the extent related to water quality) of any substance which has been discharged by a plant (or of any substance resulting from any discharge from a source)

- Information necessary to determine the identity, amount, frequency, concentration, or other characteristics of the substances which, under an applicable effluent limit, the plant was authorized to discharge (including, to the extent necessary for such purpose, a description of the manner or rate of operation or production of the plant)

- A general description of the location and/or nature of the discharger to the extent necessary to identify the effluent and to distinguish it from other effluents (including to the extent necessary for such purposes, a description of the device, installation, or operation constituting the source).

It is intended that this definition would be written into the Effluent Limits Regulation, and would serve as the basis for classification of "effluent data".

For purposes of implementation of the Effluent Limits Regulations, the following would fall within the meaning of "Effluent Data":

- Plant and stream identification
- Flow
- Regulated substances and parameters (including loadings or concentrations specified in the regulation)
- Monitoring for assessment substances and parameters (including loadings or concentrations specified in the regulation)
- Production information, if production-based limits are used

- Best management practice (BMP) plans or reports required under the regulation.

FOIA

The information supplied by the plants (other than effluent data) is governed by section 17 of the Freedom of Information Act. This section states that:

> *A head shall refuse to disclose a record that reveals a trade secret or scientific, technical, commercial, financial or labour relations information, supplied in confidence implicitly or explicitly where the disclosure could reasonably be expected to:*
>
> *a) prejudice significantly the competitive position or interfere significantly with the contractual or other negotiations of a person, group of persons, or organization;*
>
> *b) result in similar information no longer being supplied to the institution where it is in the public interest that similar information continue to be so supplied; or*
>
> *c) result in undue loss or gain to any person, group, committee or financial institution or agency.*

Once the format and content of reports are determined, the JTC should develop a tentative list of confidential components meeting the requirements of section 17 of the FOIA. The plants should identify information that they consider confidential (based on FOIA criteria), by labelling it confidential. The Ministry would then ensure this information is flagged and protected from release to the public.

However, it should be remembered, that in the event of a FOIA request, the final determination of confidentiality rests with the FOIA Commissioner.

Alternative 2:

The public is to have access to data on contaminant discharge to surface waters and on the effluent limits set for all discharges. Nevertheless, there is a need to identify and protect a firm's confidential information. The FOIA provides the legal basis for maintenance of confidentiality. In addition, clause 130 of the Environmental Protection Act states, "*Except as to information in respect of the deposit, addition, emission or discharge of a contaminant into the natural environment, every provincial officer shall preserve secrecy in respect of all matters that come to his knowledge in the course of any survey, examination, test or inquiry under this act or the regulations and shall not communicate any such matters to any person....*".

It is understood that the FOIA would take precedence over clause 130. However, any data concerning contaminants in the discharge to surface water via final effluents from a MISA direct discharger would be considered as public information.

FOIA

The information supplied by the plants is governed by section 17 of the Freedom of Information Act. The FOIA should continue to apply for all data supplied under MISA until it is clear that the regulations would be unduly constrained without a change. Meanwhile, it is inappropriate to define effluent data for the purpose of restricting the application of the FOIA.

Reporting Levels of Non-compliance

Alterntaive 1:

Although it may be considered, there is no requirement or obligation to differentiate between various levels of non-compliance, for example, effluent limits exceedance, other technical or procedural deviations.

Alternative 2:

Reports should differentiate between non-compliance with consequential components that relate directly to environmental effects versus other non-compliance, for example, with technical or procedural deviations.

Comparison of MISA Direct Dischargers to Other Sources

Alternative 1:

At some point, consideration may be given to relating MISA direct dischargers to other sources, but it is not anticipated that this would be done in the immediate future, due to the intensive manpower and systems requirements, as well as the incompleteness of the data bases.

Alternative 2:

The "MISA Aggregate Twelve-Month Monitoring Summary Report" and the "Annual Direct Discharger Monitoring and Compliance Summary" should relate the contribution of Ontario's direct dischargers to other sources including municipal CSO's, foreign direct dischargers, airborne sources, agricultural runoff, etc., especially for significant waterways such as the Great Lakes.

MISA REPORTS

Title: Six-Month Monitoring Regulation Summary Report
(Petroleum and Organic Chemical Regulations only)

Contents:

1. Brief description of Dischargers
2. Brief description of monitoring requirements
3. Brief discussion on interpretation of low level organic monitoring data.
4. Description of toxicity data interpretation
5. Summary of analytical results as received including
   - frequency detected
   - average of detected
   - loadings
   - contaminants not detected
   - QA/QC data
6. Toxicity results
7. Audit sample results (if available)

Note: Limited interpretation of results

Frequency and Timing:
One report each for Petroleum and Organic Chemical sectors
Prepared 12 months after start of monitoring

Author:
Sector Specialist with input from Toxicity Unit and Data Management Unit

Notes:

1. General format to be tabled at the JTC
2. For the Petroleum Refining Sector, there will also be a second Six-Month Monitoring Regulation Summary Report. This will be done in order to expedite release of monitoring data to the public while the issues of Monitoring Data Analysis and Reporting to the Public are still being finalized.

   After these issues are finalized, it is still scheduled that a Monitoring Regulation Summary Report (see next page) for the Petroleum Refining Sector will be published.

Title: Monitoring Regulation Summary Report

Contents:

1. Brief description of Dischargers
2. Brief description of monitoring requirements
3. Brief discussion on interpretation of low level organic monitoring data.
4. Description of toxicity data interpretation
5. Summary of analytical results as received including
   - frequency detected
   - average of detected
   - loading
   - contaminants not detected
   - QA/QC data
6. Toxicity results
7. Audit sample results
8. Status of submissions
9. Interpretation of QA/QC and Audit results
10. Raw data (rejected data identified)
11. Summary of contaminant loadings by plant.

Frequency and Timing:

One report each for 9 sectors
Prepared 8 months after monitoring

Author:

Sector Specialist with input from Toxicity Unit and Data Management Unit

Notes:

1. Items 1 to 7 above are the same as 6 month summary
2. General format to be tabled at the JTC
3. Detailed statistical analysis carried out

Title: Report on the Industrial Direct Dischargers in Ontario

Contents:

1.Summary of effluent limit requirements
- effluent guidelines limits
- legal limits in C of A and Control Order

2.Compliance
- compliance and exceedances summary

3.Abatement and Remedial Actions
- remedial actions summary
- enforcement action summary

4.MISA Monitoring Regulations
- status and summary
- sectoral trends

5.Discharge summary for each discharger
- company name and location, receiving waterbody, etc.
- effluent characteristics and treatment
- type of limit
- exceedences
- discharger remedial action
- effluent data

Frequency and Timing:

Annually on a calendar year basis
Released in the Fall of the following year

Author:

Data Management Unit with input from Industrial/Municipal Section, Toxicity Unit, Regional Operations, and Investigations and Enforcement Branch.

Notes:

1. This report is a continuation of an existing report of the same name. It would eventually incorporate MISA limits data, and would evolve into the Annual Direct Discharger Monitoring and Compliance Summary.

Title: MISA Aggregate Twelve-Month Monitoring Summary Report

Contents:

1. Identification of sectors
2. Brief summary of monitoring requirements
3. Aggregate loadings by sector of contaminant categories
4. Relating of MISA Industrial and Municipal sectors to each other in terms of total contaminant contribution
5. Toxicity results by sector
6. Graphic displays of results to facilitate interpretation of monitoring data

Frequency and Timing:

One report for 9 Industrial and 1 Municipal Sector
Prepared after completion of 12-month monitoring period by all sectors

Author:

Sector Specialists with input from Toxicity Unit and Data Management Unit

Note:

1. General format to be tabled at the JTC.

Title: Limits Regulation Development Document

Contents:

1. Identification and description of plants in Sector.
2. Description of monitoring regulation requirements
3. Results of monitoring regulation.
   (summary of 12 month report)
4. Sub Categorization approach and categories
5. Performance of plants, ie. average and variable characteristics
6. Designation of BATEA performance.
7. Comparison of plants to BATEA performance.
8. Limits reg monitoring requirements
   - parameters with limits
   - parameters for monitoring only
9. Reporting requirements.

Frequency and Timing:

One report each for 9 Sectors
Prepared 20 months after start of monitoring.

Author:

Sector Specialist with input from Toxicity Unit and Data Management Unit

Note:

1. This document developed within the JTC.
2. This document tabled at the JTC prior to release for public comment and subsequent regulation promulgation.

Title: Semi-Annual Compliance Summary

Contents:

1. Compliance status of dischargers
   - Submissions of data and reports
   - Limits
2. Ministry actions - abatement/ enforcement
3. Remedial plans and schedule for compliance
4. Results of audit inspection program

Frequency and Timing:

Prepared 3 months after end of each half.

Author:

Water Resources Branch with input from Regional Operations.

Note:

1. This report would be brief and of a summary nature.

Title: Annual Direct Discharger Monitoring and Compliance Summary

Contents:

1. Compliance status of dischargers
2. Ministry actions - abatement/ enforcement
3. Remedial plans and schedule for compliance
4. Compliance trends - year to year comparison
   - including possible comparisons to base monitoring period
   - comparisons by sector and categories of contaminants
5. Results of audit inspection program
   - including historical trends in contaminant levels in direct discharger effluents
6. Monitoring summary under the Limits regulation
7. Sectoral and cross-sectoral review

Frequency and Timing:
One report for 9 Industrial Sectors - one for Municipal
Annually - October of year following

Author:
Compiled by Water Resources with input from Regional Operations

Note:

1. The Annual Direct Discharger report would eventually develop into this report.